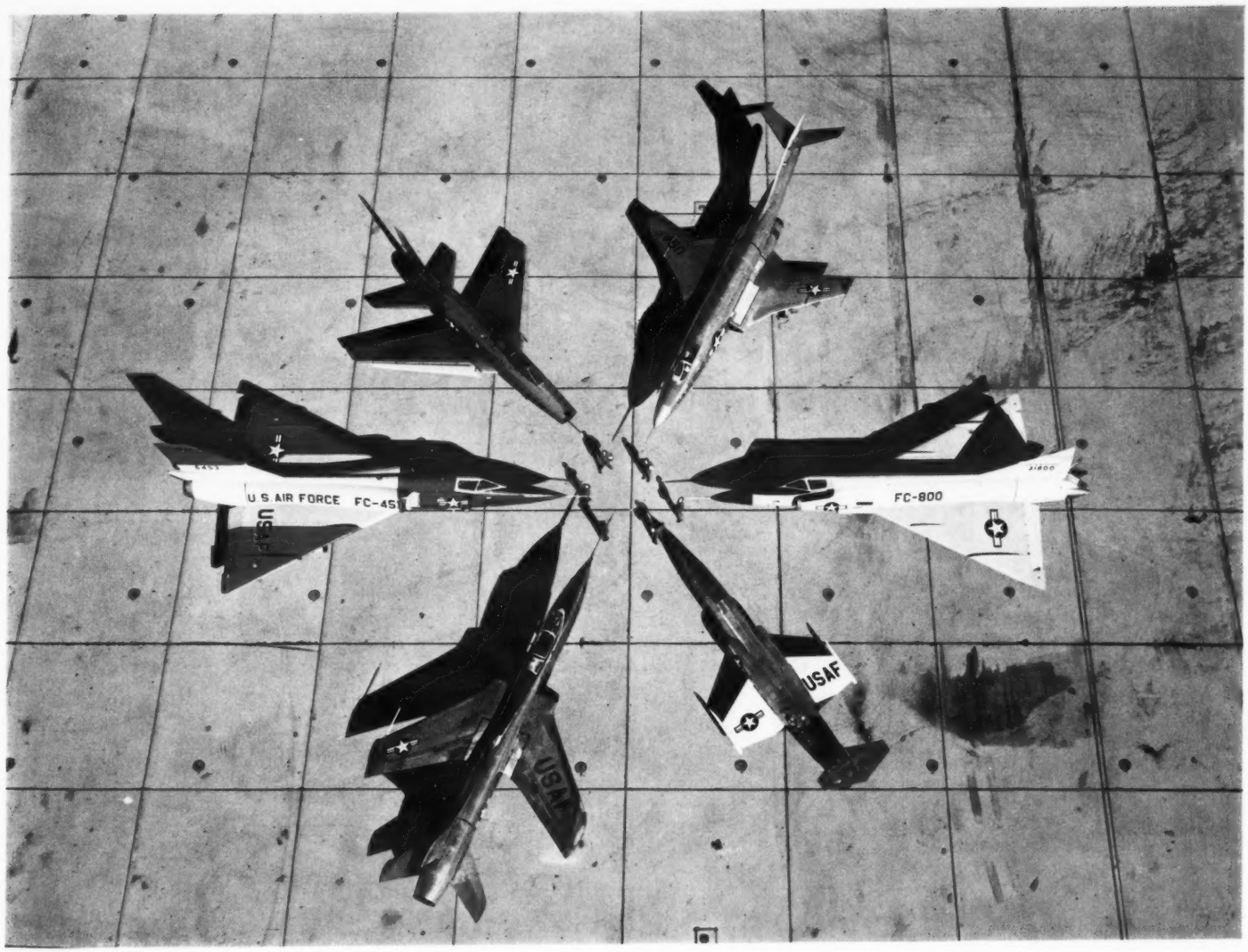
INTERAVIA

REVIEW OF WORLD AVIATION



Price of this issue —
U.S.A.: 80 cents
British Isles: 3/6
Switzerland: Fr. 2.80
Netherlands: Fl. 2.50
Denmark: Cr. 5.-
Germany: DM 3.-
France: Fr. 300
Italy: Lire 410
Japan: U.S.$ 0.80
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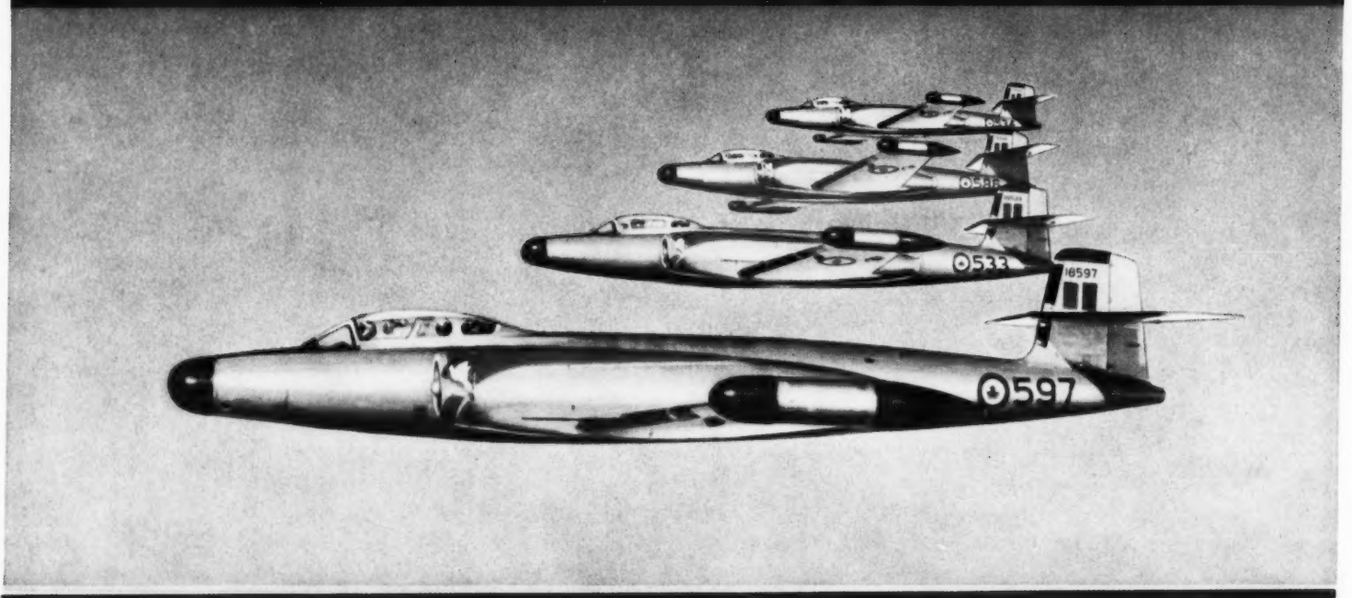
Has the West Chosen the Right Weapons?

VOLUME XIII

INTERAVIA 1933-1958 SILVER JUBILEE

No 4/1958

FOR SERVICE WITH THE BELGIAN AIR FORCE



ROCKET ARMAMENT

ELECTRONIC FIRE CONTROL

ALL-WEATHER OPERATION

HIGH ALTITUDE

AFTER TRANS-ATLANTIC DELIVERY FLIGHT

The first squadron of Avro CF-100 Mark 5 aircraft for the Belgian Air Force has been delivered for operational service.

The Avro CF-100 Mark 5 was designed to meet specifications for a long-range, high altitude, rocket firing, day or night all-weather interceptor, with automatic fire control, for the lead-collision course attack technique. It has proved its operational performance in air force squadron service on both sides of the Atlantic.

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INTERAVIA

Review of World Aviation

Volume XIII **No. 4** **April 1958**

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FRONT COVER: War dance of supersonic fighters around their pilots: clockwise, starting with the red/white Convair F-106 **Delta Dart**: North American F-100 **Super Sabre**, McDonnell F-101 **Voodoo**, Convair F-102 **Delta Dagger**, Lockheed F-104 **Starfighter**, Republic F-105 **Thunderchief**.

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Room 21, 1500 Massachusetts Ave., N.W., Washington 5, D.C.
James C. Galloway, 6535 Wilshire Blvd., Los Angeles 48, Calif.

Distributors:

Austria Morawa & Co., Wollzeile 11, Vienna I
Canada Wm. Dawson Subscription Service Ltd., 587 Mount Pleasant Road, Toronto 12, Ont.
Edward Company Regd., P.O. Box 98, Station Delorimier, Montreal P.Q.
Finland Akateeminen Kirjakauppa, Keskuskatu 2, Helsinki
Rautatiekirjakauppa Oy, Köjdenpunojank 2, Helsinki
Germany W. E. Saarbach G.m.b.H., Gertrudenstrasse 30, Cologne
Great Britain W. H. Smith & Son, Ltd., Strand House, Portugal Street, London, W.C. 2
Wymans Ltd., New Street Square, London, E.C. 4
Ireland Basil Clancy, Cooleevin, Foxrock, Co. Dublin
Japan Maruzen Co. Ltd., 6 Tori-Nichome Nihonbashi, Tokyo
Norway A/S Narvesens Litteraturtjeneste, Postboks 115, Oslo
Uruguay Humanitas, Colonia 883, Montevideo

Advertising Department: Publishing and Editorial Offices, Subscription Department: Interavia S. A., 6, Corraterie, Geneva. Telephone: 25 42 34 (five lines). Cables and Telegrams: Interavia-Geneva. Teleprinter: 22 122. Postal Cheque Account: Geneva I 5380.

Annual Subscriptions: U.S.A. and Canada, U.S. $7.00; United Kingdom and Eire, £2.2.0; Commonwealth, £2.6.0; Switzerland, 28.— fr.; Austria, 170.— sch.; Belgium, 320.— fr.; Denmark, 48.— kr.; France, 3000.— fr.; Germany, 30.— DM; Holland, 25.— fl.; Italy, 4060.— L. it.; Japan, U.S. $7.00; Latin American countries, U.S. $7.00; Norway, 50.— kr.; Spain, 360.— pts.; Sweden, 35.— kr. All other countries, 28.— Sw. fr.

Appears Monthly in Four Editions: English, French, Spanish and German.

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through

★ the extent of its equipment: ultra-modern repair shops occupying nearly 39,000 sq.ft. of covered area

★ the quality of its fleet: Super DC-6 Bs, DC-4s, Nord 2502s, Herons (several four-jet DC-8s on order)

★ the extent of its network: 50,000 miles

★ the quality of its crews, the world's most highly trained crews on the African routes

★ the reputation of its service: rewarded with the seal "Qualité France".

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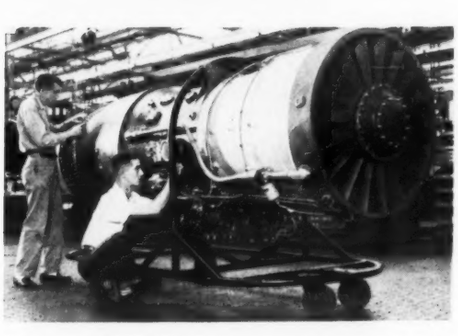
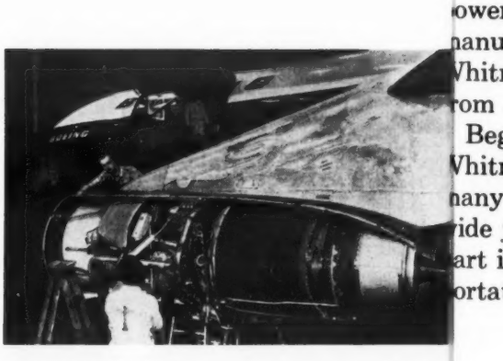
Pratt & Whitney



JT3 JET ENGINE, above, is the commercial version of Pratt & Whitney's famous J-57 It is backed by millions of flight hours and an unequalled record of dependability. Airlines have ordered more than 600 JT3 engines for installation in Boeing 707, 720 and Douglas DC-8 jet transports.



JT4 JET ENGINE, above, is more powerful tha the JT3. It is a commercial version of Pratt & Whitney's J-75, the first aircraft engine to mee performance estimates and guarantees unde actual altitude operating conditions. Commercia airlines have ordered more than 1200 JT4 engine for long-range Boeing 707s and Douglas DC-8s

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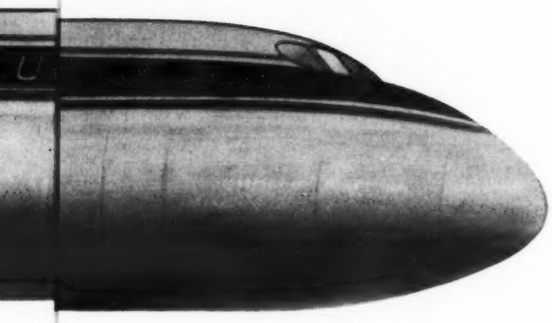

Twenty-three of the world's leading airlines have hosen Pratt & Whitney engines to power 269 large et transports—Boeing 707s and 720s, and Douglas OC-8s. This represents 90% of all the Boeing and Douglas jet transports now on order.

This overwhelming acceptance recognizes Pratt & Whitney's experience and accomplishments. In hree decades it has produced more than 425,000 ircraft engines totalling more than 1 billion horse-ower, a record unmatched by any other engine nanufacturer in the world. Today more Pratt & Whitney engines are in airliner service than engines rom all other manufacturers combined.

Beginning in 1959, jet airliners with Pratt & Whitney engines will cut flying times in half on nany important routes, introducing the age of world-ide jet air travel. Pratt & Whitney is proud of its art in bringing about this advance in world trans-ortation.

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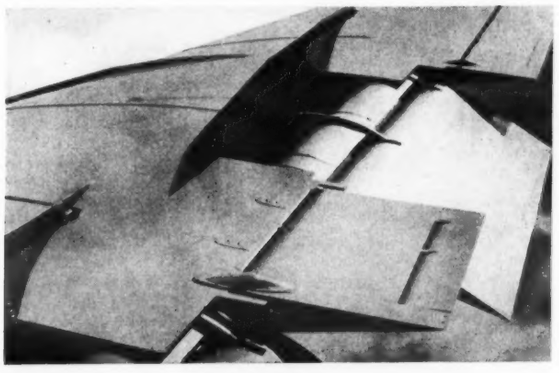
REPORT ON TRAFFIC PATTERN AND GROUND HANDLING

THE PRODUCTION BOEING 707, as demonstrated by 3 ½ years of test-flying of the prototype model, operates with ease in existing traffic patterns of commercial airports. Though it cruises at 600 mph, the Boeing jetliner's maneuvering speeds and airspace requirements for holding and instrument approaches are the same as those of today's conventional airliners.

GROUND-HANDLING poses no problems. For ground-handling and taxi characteristics of the 707—and of its shorter-range sister ship, the 720—are equal to and, in some cases, better than those of present-day commercial transports.

MANUALLY OPERATED flight control systems, proved out in hundreds of Boeing jet aircraft, give outstanding control and small airplane "feel" throughout all flight conditions. In rate of descent, the 707 and 720 offer greater flexibility than present airliners.



SPOILERS ACT AS AIRBRAKES, give added control over rate of descent. In all areas of operation, the Boeing 707 and 720 benefit from the unequalled experience Boeing gained building more than 1600 large, multi-engine jet aircraft.

BOEING
Family of jet airliners

These airlines already have ordered models of the Boeing family of jetliners:

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IS THE WORLD

THAT VALUES

Friendship

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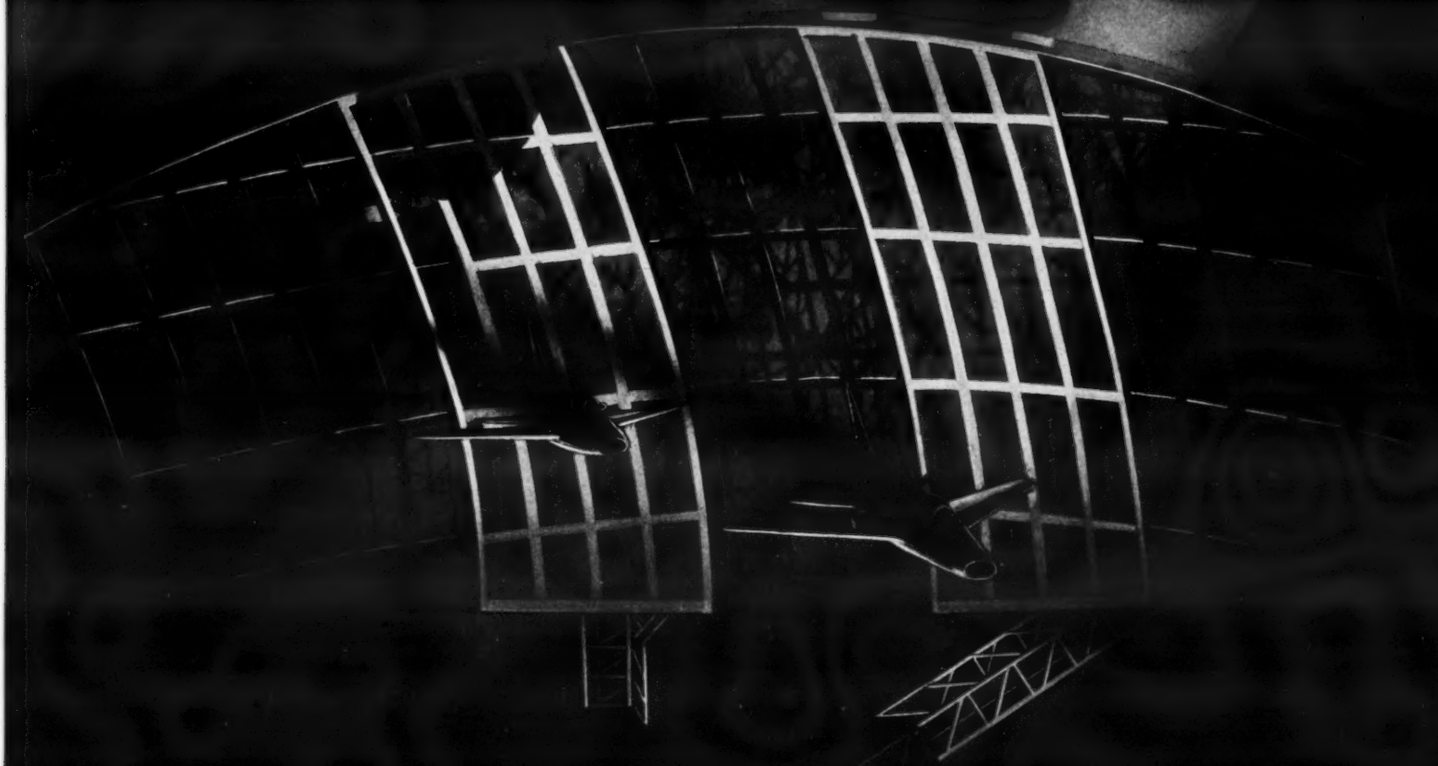

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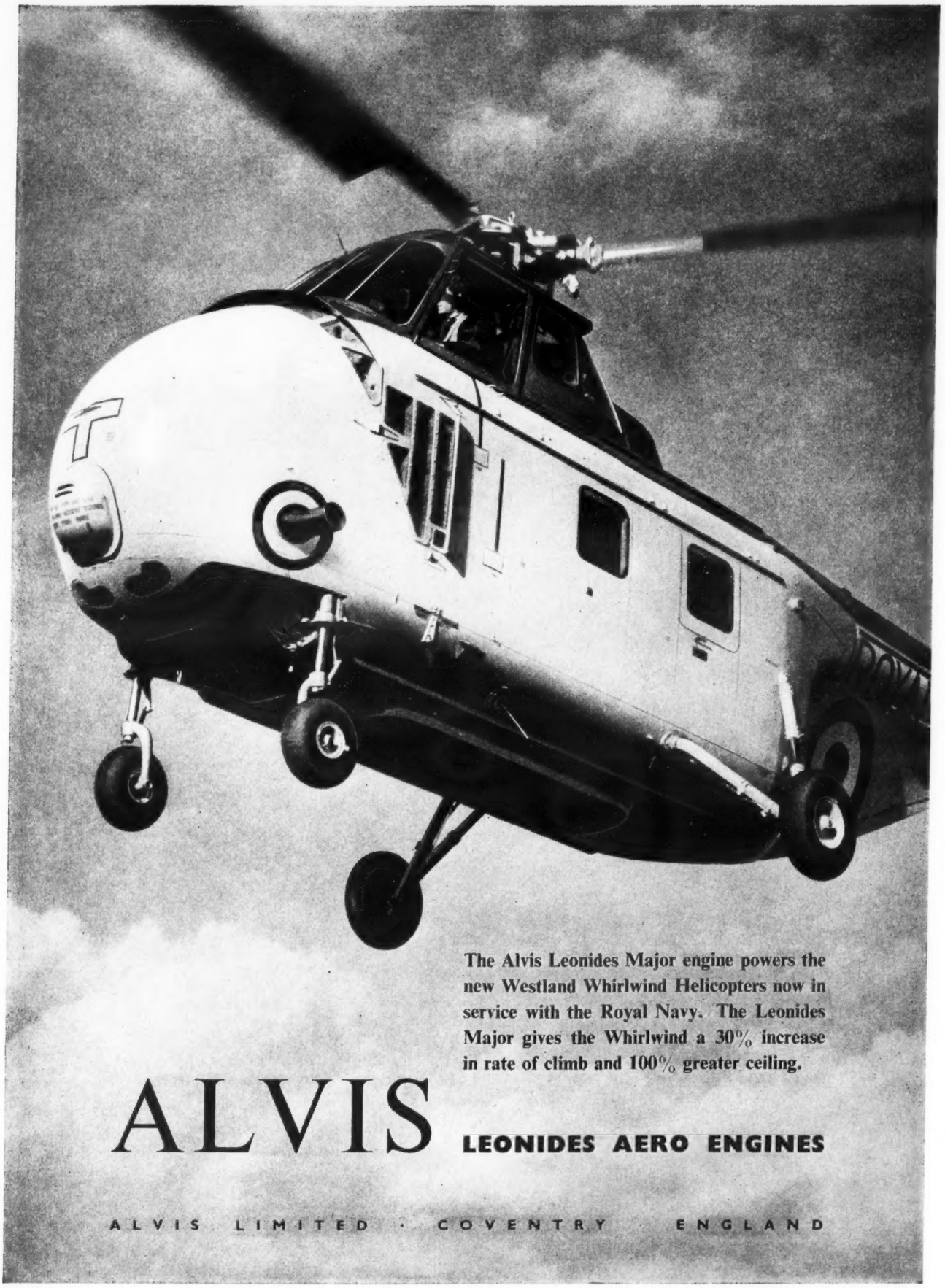
TELEFUNKEN-

Radar


The Alvis Leonides Major engine powers the new Westland Whirlwind Helicopters now in service with the Royal Navy. The Leonides Major gives the Whirlwind a 30% increase in rate of climb and 100% greater ceiling.
ALVIS
LEONIDES AERO ENGINES
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INTERAVIA

Deadline Notes

No. 4, 1958

● **Australian production of N-156F discussed :** A strong Northrop team, headed by Robert Miller, Vice President and General Manager of Northrop Aircraft, and J. Gilbert Nettleton, Vice President and General Manager of Northrop International, has held discussions in Australia with the R.A.A.F., the Department of Defence Production and Commonwealth Aircraft Corporation on the proposal that the N-156F should be built in Australia. Japan has a similar proposal under consideration, and if both took it up the licence area would be divided. Northrop is prepared to back both countries with a wide sales organization.

● **The Japanese arms industry** is planning to dispatch a guided missile inspection team to the United States in May or June to lay the groundwork for missile production in Japan with U.S. technical assistance, *Interavia's* Tokyo Correspondent reports. The mission is to be headed by Haruji Kan, Vice President of the Japan Arms Industry Association.

● **Mitsubishi Atomic Energy Industry Co.** was formed on April 1st as a joint venture by 25 companies of the Mitsubishi Group, including Mitsubishi Electric, Mitsubishi Shipbuilding, Mitsubishi Heavy Industries (Reorganized), Mitsubishi-Nihon Heavy Industries, Mitsubishi Metal Mining and Mitsubishi Trading. The new firm has an initial capital of 2,000,000,000 yen and specializes in atomic energy research and the design and production of atomic reactors. The President of Mitsubishi Atomic Energy Industry Co. is likely to be Yoshinaga Seki, President of Mitsubishi Electric.

● **The Society of Japanese Aircraft Constructors** (Nippon Koku Kogyo Kai) has tentatively decided on the specifications for a medium size transport aircraft to be manufactured in Japan. Design work on the aircraft will begin in April. The decision was made following approval by the Ministry of International Trade and Industry of a Government subsidy of 120,000,000 yen (357 yen = U.S. $1) for the project. The type of aircraft envisaged is a twin-engine turboprop transport for 60 passengers with a cruising range of 1,000 miles and a maximum speed of 320 m.p.h. Its weight is to be about 19.5 tons. Three of these aircraft are to be built within five years at a total cost of 3,000,000,000 yen. The society's members are Mitsubishi Heavy Industries (Reorganized), Kawasaki Aircraft, Fuji Heavy Industries, Shin Meiwa Industry, Showa Aircraft Industry and Nippon Aircraft Co.

● **Svenska Aeroplan A.B.,** Linköping, has been appointed by Sud-Aviation to be the latter's agent for the *Alouette II* in Sweden. According to *Interavia's* Stockholm Correspondent, the agreement concluded between the two companies also contains an option for the manufacture of the *Alouette II* by Saab and a clause on technical cooperation. Saab will also train pilots and ground crews.

● **A.B. Bofors** announces total sales amounting to 367,000,000 Swedish crowns for 1957, compared with 343,000,000 crowns for 1956. Net profit was 8,200,000 crowns, compared with 8,600,000 for 1956. The Board of Directors is proposing to the general meeting of shareholders the payment of an unchanged dividend of 8 percent (7,400,000 Swedish crowns).

● **Sud-Aviation** now has 26 firm orders for the SE.210 *Caravelle* : Air France 12, Scandinavian Airlines System 6, Finnair 3, Air Algérie 3, Varig 2. Further orders are expected shortly from Air France, S.A.S. and Varig, bringing the total number of *Caravelles* ordered to about 50.

● **Compagnie Française Thomson-Houston** formally inaugurated its new Electronics Centre at Bagneux in mid-March. The new facility, which comprises numerous laboratories, will be fully occupied by the end of April and will house the company's research and design teams which had previously been dispersed throughout the Paris region. While the new centre will be used only for all types of electronic development and research, production activities will continue to be concentrated at the company's factories in the Genevilliers-Anières region.

● **French Air Ministry Technical Chief resigns :** Engineer General Louis Meyer has handed in his resignation as Technical and Industrial Director in the office of the Secretary of State for the Armed Forces, Air. The resignation, which was accepted by the Government, emphasizes the critical position in which the French aircraft industry finds itself as a result of the budget cuts. Engineer General Meyer asked to be relieved of his duties because he felt that the reduction in defence expenditures would make it impossible for him to carry out his task. He has agreed to continue in his post until a successor is appointed.

● **SIAI Marchetti** has taken over the sales agency for the whole of Western continental Europe for the arrester lines and nets developed and produced by All American Engineering Co.

● **An aerial photography research and training centre** is to be established at the Milan Polytechnical Institute with the help of Ottico Meccanica Italiana & Rilevamenti Aerofotogrammetrici, of Rome, Ottico Galileo, of Florence, and various Government departments.

● **Auster Aircraft** has received a contract for nine agricultural aircraft from the firm of Crop Culture (Aerial) of the Isle of Wight. A French company, Ardic of Dakar, has also placed a contract for five of these machines, to be known as the Auster *Workmaster*. The *Workmaster* will carry 100 gallons of chemicals and do spray work at speeds up to 90 m.p.h. It will have a 180 h.p. *Lycoming* engine, its cruising speed will be 88 m.p.h., and take-off run fully loaded 180 yards. The prototype *Workmaster* has already been flown.

● **Convair Division** of General Dynamics Corporation has been awarded a $8,000,000 contract by the U.S. Navy for pilot line production of *Tartar* guided missiles (with solid-propellant rocket motor). According to a Navy Bureau of Ordnance announcement, the pilot line missiles, to be produced at Convair's plant in Pomona, Calif., will be used for testing and evaluation at the Naval Ordnance Test Station at China Lake, Calif., and on board the U.S.S. *Norton Sound*, prior to going into full production.

● **France's civil aviation budget** has been adopted by the National Assembly. It provides for current expenditures of 16,720,000,000 francs, plus authorized commitments totalling 15,500,000,000 francs (as against 14,706,000,000 francs in 1956). Two-thirds of the total amount are earmarked for airport development and airways improvements, the rest will be used to subsidize aircraft production (the State is contributing towards the *Caravelle* programme and the construction of the two Breguet 941 *Intégral* prototypes). The money voted for ground facilities will mostly be spent on air traffic control installations and improvements at a number of airports required for the introduction of jet aircraft (Le Bourget, Orly, Dakar, Abidjan, Lomé, Niamey, Brazzaville, Douala and Fort Lamy).

● **Hilton Hotels Corporation** is embarking on a programme to build a number of 300-bed hotels adjacent to airports of leading U.S. cities. Land has already been leased for this purpose near San Francisco International Airport. Similar negotiations are under way in Los Angeles. Other prospective cities include Washington, New York, Chicago, Detroit, Boston, New Orleans, Miami and Seattle.

● **Mascot Airport, Sydney :** Qantas Empire Airways' £A 6,000,000 development programme for Mascot Airport Sydney, will involve construction of a new technical training centre (£A 145,000) ; a new jet engine test cell (£A 100,000) capable

of handling engines up to 30,000 lb. thrust ; a new repair and overhaul shop (£A 625,000) to cover 140,000 sq. ft. and be manned by a staff of 600 in one shift ; a line maintenance hangar, block overhaul hangar and fuel tank farm. The technical training centre will house three Link trainers, a Redifon trainer, a flight simulator for the Boeing 707 (with provision for another) and Telerama equipment.

● **Swissair's annual report for 1957** shows that the acquisition of new aircraft enabled the company to increase its number of tonne-kilometres available by 53 percent. The airline's third and fourth DC-7C were put into service and a fifth DC-7C was ordered. The Convair 440 *Metropolitan* fleet was brought up to eleven aircraft. Extracts from the operating results : available tonne-km—169,176,531 (compared with 110,402,912), total revenue tonne-km—104,235,336 (83,201,432 in 1956), passengers carried—992,911 (773,956), average load factor (scheduled services)—61.6 percent (66.5 percent). The general assembly of shareholders, which has been convened for April 2nd, will be asked to approve a proposal by the Board of Directors that the share capital be increased by 50 percent—from 42,000,000 Swiss francs to 63,000,000 francs.

● **Air Algérie** has placed an order with Sud-Aviation for three SE.210 *Caravelle* medium-range jet transports. Delivery will take place in January, February and March 1960.

● **Ansett-A.N.A.** has sold five of its remaining seven DC-4 *Skymasters* to the American Twentieth Century Aircraft Co. for one million dollars cash. All the aircraft will be delivered to the U.S.A. by the middle of June. In another deal Ansett-A.N.A. has sold at least three of its DC-3s to Thailand at a price of $100,000 each.

● **The Japanese defence estimates** for the financial year beginning April 1st, 1958, provide for a total manpower strength of 225,000, including 170,000 Army, 26,000 Navy and 29,000 Air Force. Expenditure in 1958/59 will exceed the figure for the current financial year by 28,400,000,000 yen (357 yen = U.S. $1). The Defence Agency will have at its disposal 129,800,000,000 yen. Of this, 4,800,000,000 will be for joint expenses of the three services, 60,200,000,000 for the Army, 28,800,000,000 for the Navy and 36,000,000,000 for the Air Force. With the sixty F-86D fighters and six C-46 transports which Japan hopes to receive from the United States and the approximately 150 combat and trainer aircraft to be manufactured in Japan, the Air Force will have a fleet of nearly 1,000 aircraft.

● **The Swedish Navy** recently received the first two of four Vertol 44 helicopters ordered. *Interavia's* Stockholm Correspondant understands that the Navy's first helicopter unit is to become operational in 1959. It will be equipped with six Vertol 44s, two Sikorsky S-55s (leased from Ostermans Aero A.B.) and four small helicopters (probably Bell 47s). Ultimately, the Swedish Navy plans to establish four helicopter units of 12 machines each. The sale of Vertol 44s in Sweden is handled by Salén & Wicander A.B. which is trying to interest S.A.S. and Linjeflyg in the Vertol 44 for feeder services between Bromma and Halmsjön airports.

● **General Paul Bailly** has relinquished his duties as Chief of Staff of the French Air Force for reasons of health. He becomes Inspector General of the Air Force, and is succeeded by General Max Gelée, who was formerly Inspector General of the Air Force. Informed circles link General Bailly's action with the recent resignation of Engineer General Louis Meyer from the post of Technical and Industrial Director in the office of the Secretary of State for Air. There is evidence of widespread dissatisfaction among Air Force leaders over the recent Government cuts in France's aviation budget.

● **The U.S. Navy's** aircraft carrier *Corregidor* recently unloaded a Republic RF-84F aircraft at Naples, which brought the total equipment supplied to the Italian armed forces under the Mutual Assistance Programme since 1950 to 1,000,000 tons. Of this total, the Army has received 440,000 tons, the Air Force 465,000 tons and the Navy 95,000 tons. Altogether, 775 ships were used to ferry the equipment to Italy.

● **Transports Aériens Intercontinentaux** (T.A.I.) : The company's net profit in 1957 was 156,800,000 francs, compared with 150,104,000 francs in 1956. Total sales were 6,453,000,000 francs (5,412,000,000 francs in 1956). In addition to increases in prices and wages, 1957 was burdened with exceptional charges such as the temporary extra expenses involved in the prohibition of landings at Cairo, the engagement of new personnel and the training of pilots on the DC-7Cs now coming into service. The Board plans to propose to the General Meeting on April 2nd the distribution of a dividend of 15 percent (unchanged) on the par value of shares (375 francs), which will absorb a sum of 98,400,000 francs, the payment of 20,000,000 francs to the shareholders' extraordinary reserve fund (raising the latter's total to 180,000,000 francs) and a carry forward of 5,960,000 francs to the new account. The sum of 17,424,000 francs will be paid to the company's staff cooperative and distributed among the staff.

Workshop Briefs

● First test launching of the Fairchild SM-73 *Bull Goose* at Cape Canaveral has been reported.

● A new air-to-surface guided missile—the *Gander*—has been mentioned for the first time. This missile is also reportedly under development by Fairchild.

● Gloster *Javelin Mk. 7*, the latest version of this all-weather fighter, will be able, if required, to carry rocket projectiles (37) and a *Firestreak* guided missile under each wing, as well as 30-mm Aden cannon. It is believed that in addition to the *Javelin*, the DH. *Sea Vixen*, and the English Electric P. 1 are also equipped to carry rocket projectile batteries.

● The first A3J naval bomber, under development by North American Aviation for deployment on aircraft carriers, is scheduled to commence its flight testing in July this year. First mention has also been made of a long-range version of the A3J.

● Data have become available for Industriewerke Dresden's *BB-152* four-jet commercial transport for a maximum of 72 passengers : span 86.2 ft. ; length 103.0 ft. ; wing area 1,485 sq.ft. ; gross weight 88,180-99,210 lb. ; payload 12,125 lb. ; cruising speed 430 knots ; landing speed 108 knots ; take-off run 3,215 ft. ; cruising altitude approx. 33,000-39,000 ft. ; range up to approx. 1,600 nautical miles ; 48 to 72 passengers. The powerplant consists of four 014 turbines built by VEB Entwicklungsbau Pirna.

● Fullercraft Corp., Tacoma, Washington, is marketing a two-seat lightweight helicopter designated *Colibricopter*, at the price of $1,500. Powered by a turbine unit, it is said to have a payload of about 1,000 lb.

● GAM Dassault's Saint-Cloud plant has just commenced manufacture of a pre-production batch of *Mirage III* single-seat fighters. The aircraft is fitted with an *Atar G* of 9,920 lb. thrust with afterburner.

● The first production model of the Morane-Saulnier MS.760 *Paris* has made its first test flight.

● Several British designers are working on VTO designs for a lightweight tactical aircraft capable of operating in advanced combat areas.

● A military version of the Rolls-Royce RB.141 by-pass engine of 12,000 lb. thrust is announced ; designation *RB.141R*.

● The first Morane-Saulnier MS.1500 *Epervier* low level attack and police aircraft has been completed and will probably have made its first test flight by the time these lines appear.

● The first flight of the Handley Page *Dart Herald* was made from a grass runway at Woodley on March 11th, 1958. The aircraft was flown by Sqn. Ldr. H. G. Hazelden, Handley Page's Chief Test Pilot.

● The first Boeing B-52G *Stratofortress* will roll off the production line during the summer of 1958. Developed from earlier B-52 models, the B-52G will have more powerful engines, a modified fuel system and considerably increased range ; maximum speed will be in the order of 565-plus knots. The new B-52G will be equipped to mount the GAM-77 *Hound Dog* air-to-surface missile now in production by North American.

● *Towkar Model TK30* is the designation of a new towing tractor for aircraft, designed by Silent Hoist & Crane Co., Brooklyn, N.Y. Various sizes of this equipment are available.

● The *Napier Eland NEl. 6* (3,500 s.h.p.) turboprop engine has successfully completed an official 150-hour acceptance test.

● *A seven-ton rocket sled*, equipped with a liquid-propellant rocket motor developing some 160,000 lb. of thrust, is under development by the *Rocketdyne Division* of North American Aviation Inc. The sled will be delivered in autumn 1958 to the U.S.A.F. for high-speed tests at Holloman Air Development Center. Designated RS-2, it will be 43 ft. in length ; height is only 40 inches. It is expected that this vehicle will be able to accelerate a one-ton payload with 15g and attain top speeds of 2,500 ft/sec.

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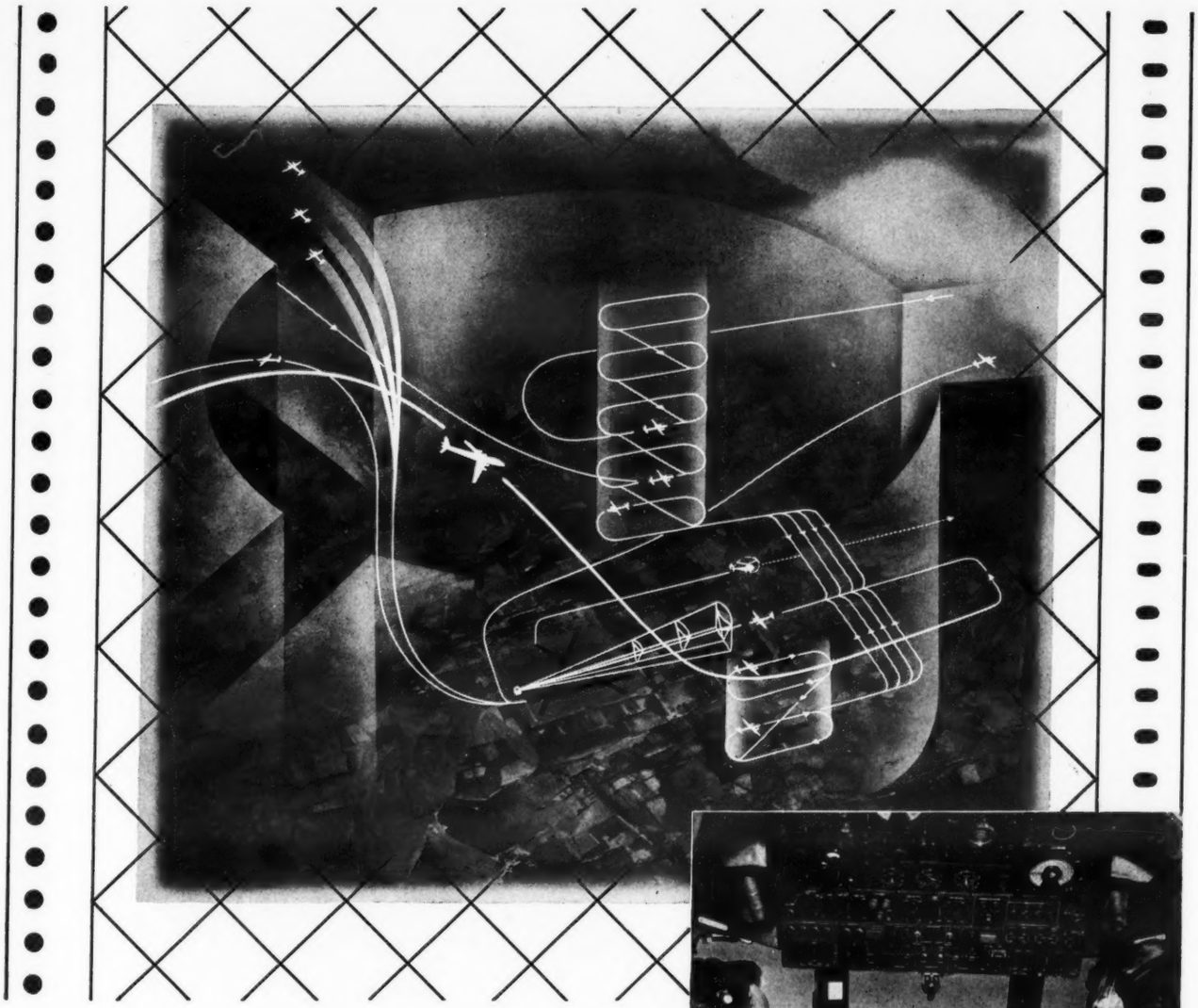

Decca in the Jet Age

As more high-performance turbo-prop and turbo-jet aircraft come into service, so the problems of Air Traffic Control become more acute. For these aircraft, precise navigation is more than ever the paramount need if they are to climb and descend safely through varying levels of medium and low altitude aircraft.

The accuracy and flexibility of the Decca Navigator, which continuously pin-points the pilot's exact position, ensures the efficient working of any traffic pattern, however complex. Holding areas can be designated and flown precisely at any altitude however high. No other aid can do this. Furthermore, no re-positioning of ground facilities is required if airways, terminal area procedures or holding patterns have to be changed for any reason.

The Decca Navigator can do much to reduce separation standards, so essential to economical use of air space. Indeed, it is the inherent precision and reliability of the Decca System that adds to the safety of high-performance aircraft, both in terminal areas and en route.

All BEA Viscounts are fitted with the Decca Navigator. Invaluable information on the requirements of jet age air traffic has been gained from over four years' operation in these aircraft.

THE DECCA NAVIGATOR

THE WORLD'S MOST ACCURATE NAVIGATION SYSTEM

THE DECCA NAVIGATOR COMPANY LIMITED LONDON

The splendour of the aurora borealis spreads over the strange polar sky. With no wind and calm atmosphere, the polar route is the smoothest of all air routes. Numerous aerodromes mark your route during the long polar night which lasts from November to May. April sees the dawn of the six-month "day" when the sun untiringly circles the horizon, without ever setting...

AIR FRANCE : *Paris-Tokyo via the pole*

the fastest polar route between Europe and Japan

Paris-Tokio
8,200 miles
in less than
30 flying hours
via the
Polar Route

LONDON-TOKYO	31 hrs. 10 mins. flying
GENEVA-TOKYO	31 hrs. 20 mins. flying
ZURICH-TOKYO	32 hrs. 30 mins. flying
MUNICH-TOKYO	32 hrs. 40 mins. flying
DUSSELDORF-TOKYO	32 hrs. 00 mins. flying
FRANKFURT-TOKYO	32 hrs. 00 mins. flying
BARCELONA-TOKYO	32 hrs. 40 mins. flying

Air France deferred the launching of this new service until it had received the world's fastest aircraft over the longest distances : the Super Starliner. Thus its northern Paris-Tokyo service is today the shortest : less than 30 flying hours, with only 1 hour's call at Anchorage, Alaska. The return flight is even shorter : 27 hrs. 30 mins. only from Tokyo to Paris.

The Super Starliner is not only extra fast, but is also the most silent. Its berths and sleeper-seats offer passengers complete relaxation with all the pleasures of Air France's celebrated comfort. — For the return flight you can choose the southern route at no extra charge, via Hong Kong, Manilla, Bangkok, Calcutta, Rome...

At the pole as in the tropics, Air France places at your service the most modern of aircraft flown by top-grade crews, and the incomparable experience of the company which operates the longest of all route networks.

AIR FRANCE THE SPECIALIST LONG-RANGE AIRLINE

publicité U&O

New flashing lamps guide pilot to landing through snow or fog

Flashing with the brilliance of lightning, a new Westinghouse approach lighting system will help pilots to make safe bad-weather landings at several major U.S. airports. The system, which features a series of new condenser discharge lamps leading up to the runway, was recently approved by both the U.S. Civil Aeronautics Administration and ICAO.

In operation, the lamps flash one after the other, twice every second. This produces the effect of a moving arrow of light which guides the pilot to the runway. Despite the brightness of the flashes — enough to penetrate snow or fog — the pilot's eyes retain full light sensitivity since each flash lasts only 150-millionth of a second.

This new system can supplement either the ALPA ATA or Calvert approach lighting configurations, for which Westinghouse also makes complete equipment. In fact, wherever planes fly today, Westinghouse aviation lighting equipment is on the job, backed up by Westinghouse radio control and power-distribution equipment. Write for "Booklet C1".

If you'd like additional information on the developments shown here or help on specific lighting or electronic problems, write to Westinghouse, Box 345, Wall Street Station, New York 5, U.S.A.

French fighter carries Westinghouse all-weather armament control system

Latest aircraft to be equipped with a Westinghouse armament control system is the French Navy's Aquillon fighter. In the advanced AN/APQ-65 pilot-operated system, search-track radar finds the target and a computer automatically calculates the best attack course and firing data.

The high accuracy and great range of Westinghouse air-borne fire control systems have also earned them a job on aircraft of the British Royal Air Force and Royal Navy as well as the U.S. Navy. Other Westinghouse developments in this field include adaptations of the AN/APQ-65 for a variety of advanced weapons. In addition, extensive design and development work in Westinghouse laboratories is continually producing improvements in weapon control systems to match stiffening military requirements.

YOU CAN BE

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IF IT'S

Westinghouse

Grumman Super Tiger all-weather supersonic fighter

Pilots from many different countries who have flown the Super Tiger all agree that it is the world's best and most versatile air superiority fighter. They also praise the aircraft's outstanding handling characteristics, which ensure safety up to maximum performance.

Simple in design and powered by a General Electric J79 jet, the Super Tiger unofficially set up two world records in 1956 by attaining a maximum level speed of more than 1,220 m.p.h. and an altitude of more than 77,100 ft.

Because of Grumman's experience in the construction of over 20,000 carrier-based aircraft, the Super Tiger is particularly suited for operation from short fields.

The Grumman Corporation has built up an extensive network of specialists throughout the world, who are at the service of customers at all times.

Grumman

GRUMMAN AIRCRAFT ENGINEERING CORPORATION Bethpage · Long Island · New York

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L'avion de l'avenir pour les très grandes vitesses

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allumage stato zp 4000 m., mi [redacted], k 4,5. acceleration en
jusqu à mi 0,9 puis montée standard vi [redacted] kts, ra 0,7.
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mi = 1,85. le pilote coupe volontairement
en forte montée (il n a pu dire l altitude au
tion)
en cours de descente, mi = [redacted] tonn[redacted]

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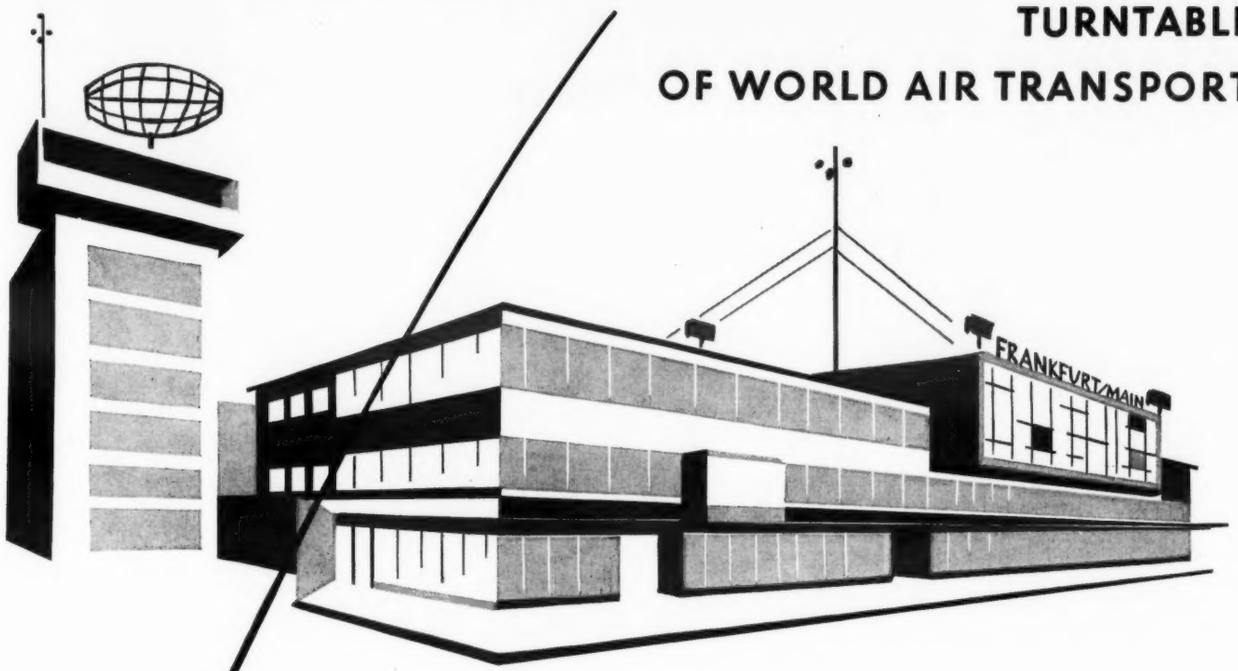

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READY FOR THE JET AGE IN INTERCONTINENTAL SERVICE

Its high traffic volume, its central location in the heart of Europe and most favourable ground transport connections to all parts of Western Germany have made Frankfurt/Main airport into the most important and heavily used in Germany.

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OVER 50 AIRLINES

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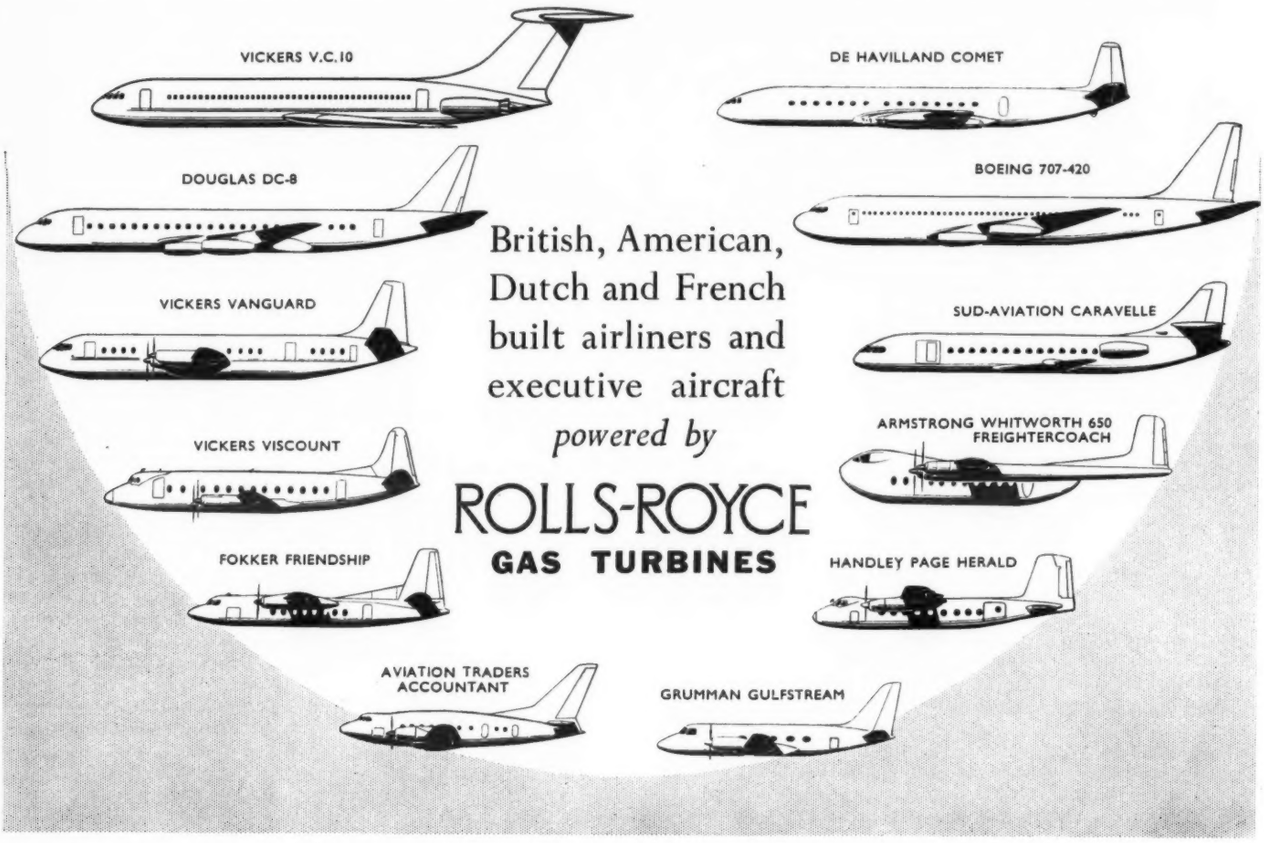

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The U.S. Aircraft Industry in Mid-March 1958

BY SCOTT HERSHEY, NEW YORK

The securities market which came in like a lion on the first trading day in March quickly assumed lamb-like tendencies and then developed strength which even the loss of the second U.S. satellite with a *Jupiter* missile failed to dent.

Chrysler, the contractor for the *Jupiter* came to life on the day of the launching and was up past a point and finally closed at 50 ¾. Off-setting this in the aircraft picture was Curtiss Wright which tumbled two points to another new low, closing at 22.

The Curtiss Wright situation was in the face of a report which showed the company had one of its best years in 1957 with sales reaching $598,621,622, compared with $571,464,795 in 1956. Net for 1957 declined, however, to $40,075,582 versus $43,153,513 in the previous year.

Roy T. Hurley, Chairman and President, said Curtiss Wright's program of diversification and expansion into new commercial fields, which was begun eight years ago, resulted in an overall 6.7 percent profit after taxes in 1957.

While gloom is a fairly common commodity in Wall Street these days, the market, as mentioned before, has shown some resistance. And, observers point out, for every seller there must be a buyer and with all the selling in the past few months someone has been buying.

It is the opinion of many experts that the buyers have been those with a long-range viewpoint who are not so much concerned with what the economy will do in the next month or two, but what it will do over the long range. There is money for stock purchases, as a number of successful secondary distributions have indicated. Long-term investors, both individuals and trustees of pension funds and the like, are willing to buy.

The market's resistance is still a minor wonder since it has been holding at what is a hysterically high level, and even the daily scores for more than 14 months are running well ahead of lows most times.

The general market situation, however, has not included aviation stocks except in special instances. Despite the prospects of large defense contracts, many manufacturers fear that missile-making will be a low profit operation.

They cite the fact that new models develop so fast, making their predecessors obsolete, that large production runs with contracts involving high profit margins will be few and far between. Another point, which is far from incidental, is the fact that the military does not have enough bases to install many of the long-range ballistic missiles.

Contracts calling for extensive research and development yield small profits at best.

On the other hand, big missiles can't be stock-piled or warehoused like artillery shells. They must be kept warmed up with the thousands of electronic components and other parts in partial operation to ensure readiness for take-off. Consequently, there is a sizeable replacement demand.

A recent check-up shows that General Dynamics Corp., makers of missiles and supersonic airplanes, has moved in as the top concern in defense contracts. In the period for two and a half years ending with June 30, 1957, end of the fiscal year, General Dynamics received contracts totaling $2 300 million. In second place was United Aircraft with awards of $1,979 million, followed by General Electric and Boeing with approximately $1,930 million. North American slipped to fifth with contracts totaling $1,800 million. Following were American Telephone, Lockheed, Hughes Aircraft, Douglas, McDonnell and The Martin Company.

The sums mentioned above are not inconsequential, but what about the companies' securities ? Recent prices on the top firms in the defense picture show this : General Dynamics 59 1/2 ; United Aircraft 57 1/8 ; General Electric 62 3/8 ; Boeing 36 7/8 ; North American 27 1/4 ; Lockheed 40 5/8 ; Douglas 56 ; McDonnell (traded on the American Stock Exchange) 25 1/2 ; and Martin 31.

There are some bright spots in the aircraft picture as witnessed by the report of United Aircraft to its stockholders that the company had record sales and earnings in the past year. United's sales rose 20 percent to $1,232,919,313 in 1957 from $952,885,142 the previous year. Consolidated net income was $51,366,108 versus $37,082,493 a year ago. Per share earnings equalled $7.96 last year compared with $5.87 the year before.

Company officials would not venture an opinion as to operating results for the current year. Operating conditions, they said, will not be as favorable as for 1957 due to the discontinuance or reduction in volume of older models or products, and prices have not been established for a large segment of Government shipments. In addition, engineering expenditures are expected to be unusually heavy.

Accordingly, although shipments for 1958, based on the present schedule, are expected to be comparable to those of 1957, officials do not expect earnings to be as favorable as last year. Company officials sought to dispel, in their report, any fears concerning the Government's shift in attention to missiles. The missile will become an essential part of the military program, they pointed out, but added " it will not displace manned aircraft in the foreseeable future and most probably never will do so."

A bright spot, too, was North American Aviation, which reported they expect sales in the 1958 fiscal year ending September 30 to be " a little over $800 million." James H. Kindelberger, Chairman, said if there was a change in this figure it would be higher.

He was revising an earlier prediction that sales in the current year would be $700 million and a forecast made earlier this month by J. L. Atwood, President, who also mentioned $700 million.

Kindelberger would make no predictions on earnings, but did say " there is considerably more optimism than at this time last year." Mr. Atwood earlier predicted that earnings for the company in the current year would be between $14 million and $21 million. In fiscal 1957 the company had sales of $1,243,767,483 and earnings of $33.8 million or $4.22 a share. North American officials commented that it would be a long time before they could expect another year like that.

Mr. Atwood said the company has a potentially favorable outlook in all fields of its endeavor and is generally in a good position. He said the B-70, the X-15 space plane and the F-108 fighter are the backbone of the Air Force of 1960, adding that they are fundamental-type aircraft and " we've got them all."

The B-70 is the company's new name for the weapons system 110 or " chemical bomber ", on which North American recently won a design competition. The company said it is necessary to the defense effort because " it has intercontinental range, will fly at nearly twice the speed of an artillery shell and will go anywhere to drop a bomb, fire a missile, take a picture, or take a look and come back."

Atwood predicted that in seven to ten years, North American's atomic international division will be able to build nuclear power generating plants which will produce power cheaper than conventional means. The largest present market, he said, is in Europe.

Briefs : Net income of Boeing for 1957 was $38,159,707 equal to $5.49 a share, against $32,134,989 or $4.63 a share on the same share basis in 1956. Sales last year were $1,596,508,515 against $1.006,536.748 in 1956 ... Douglas has received a $43.400.000 contract from Western Electric, prime contractor, for continued production of the Army's *Nike Hercules* guided missile ... Slipping aircraft employment probably will not make an upturn until next winter. The industry's total at 1957 years's end was around 800,000.

U.S. Aviation Stocks, Capital, Dividends, Prices, etc.

Company	Production *	Par Value and no. of Shares		Dividends in $ 1956	1957	Prices at 17. Mar. 58	1957 High	1957 Low	Profit per share in $ 1956	1957
Aircraft and Equipment Industry										
Bell Aircraft	① ② ③	$ 1	2 728 907	1.25	1.00	16 1/2	24 1/8	11 1/4	2.21	1.60 e
Bendix Aviation	⑤ ⑥	$ 5	5 056 788	2.40	2.40	49 3/8	66 3/4	42	5.04	5.44
Boeing Airplane	① ③	$ 5	6 797 407	1.25	1.00 + 4 % [1]	37 1/8	61 1/8	29	4.82	5.49
Chance Vought Aircraft	① ③	$ 1	1 088 500	1.60	1.60	40 3/8	49 1/4	20 5/8	3.81	5.00 e
Collins Radio	⑤	$ 1	.	0.35	0.35	over-th-counter 13 1/2	28 1/2	9 1/2	1.96	1.63
Curtiss-Wright	④	$ 1	7 795 700	2.50	3.00	23	47 3/8	23 3/4	5.64	5.00 e
Douglas Aircraft	① ③	(no)	3 705 690	4.00	4.00	56 1/2	91	50 5/8	8.96	8.28 prov.
Fairchild Engine & Airplane	① ③ ④	$ 1	3 038 272	0.25	—	8 1/8	12 1/4	6	0.64	0.25 e
Garrett Corp.	⑥	$ 2	984 718	2.00	2.00	32 1/4	54	23 1/4	5.13	5.02
General Dynamics	① ③ ⑤ ⑦	$ 1	9 285 911	1.60	2.00	56 3/8	68 5/8	46 3/4	4.14	4.90 e
General Electric Co.	④ ⑤ ⑦	$ 5	87 341 447	2.00	2.00	61 3/8	72 3/8	52 3/8	2.45	2.75 e
General Motors	④ ⑤ ⑥	$ 1.66 2/3	278 811 526	2.00	2.00	35 1/4	47 1/2	33 1/8	3.01	2.99
General Precision Equipment	⑥	$ 1	1 125 810	2.40	2.40	37	47 1/4	30 1/4	1.63	3.75 e
Goodyear Tire & Rubber	⑥ ⑧	$ 5	10 571 776	2.40	2.40	74	95 1/4	70 3/4	6.03	6.75 e
Grumman Aircraft Engineering	①	$ 1	2 200 000	2.00	1.75	18 1/8	34 5/8	15 1/4	3.50	2.90 e
Intern. Telephone & Telegraph	⑤	(no)	7 176 677	1.70	1.80	32 1/4	37 3/4	25 3/4	3.92	3.30 e
Lear Inc.	⑤ ⑥	$ 0.50	.	0.30	0.30	.	8 3/4	4	0.85	0.14 (6 mths)
Lockheed Aircraft	① ③	$ 1	2 955 361	2.40	2.40	41 3/8	57 1/8	26	5.10	5.40 e
Martin Co.	① ③	$ 1	2 922 783	1.60	1.60	31 5/8	47 7/8	26 1/2	3.73	3.25 e
McDonnell Aircraft	① ③	$ 5	1 586 089	0.50 + 3 % [1]	0.50 + 4 % [1]	.	44 3/4	18 1/8	4.55	6.34
North American Aviation	① ③ ⑦	$ 1	8 015 077	1.92 1/2	2.00	27	39 1/4	20 1/8	3.59	4.23
Northrop Aircraft	① ③	$ 1	1 527 967	1.60	1.60	22 3/4	28 1/8	15 3/4	3.28	3.62
Radio Corp. of America	⑤	(no)	13 887 449	1.50	1.50	33 3/8	40	27	2.63	2.55
Republic Aviation	① ③	$ 1	1 472 013	2.00	2.00	19 1/8	32 3/4	13	5.01	3.85 e
Sperry-Rand	⑤ ⑥	$ 0.50	28 279 311	0.80	0.80	18 1/4	26 1/8	17 5/8	1.74	1.70 e
Sylvania Electric Prod.	⑤	$ 7.50	3 526 186	2.00	2.00	35 5/8	46 1/4	29 1/4	4.11	4.10 e
Temco Aircraft Corp.	① ③	$ 1	1 676 826	0.75	0.75	.	18 3/8	8 5/8	1.35	1.04 (9 mths)
Thompson Prod.	④ ⑥	$ 5	2 762 241	1.40	1.40	45 7/8	89 3/4	46	4.60	4.90 e
United Aircraft [a]	② ④ ⑥	$ 5	6 248 978	3.00	2.63 + 20 % [1]	56 1/8	75 1/4	42	5.88	7.96
Vertol [a]	②	$ 1	.	15 % [1]	10 % [1]	over the-counter 17	45 1/2	12 1/2	5.76	2.69 (9 mths)
Westinghouse Electric Corp.	④ ⑤ ⑥ ⑦	$ 12.50	16 943 337	2.00	2.00	61 3/4	69 5/8	52 3/8	0.10	4.18
Air Transport Industry										
American Airlines		$ 1	7 917 891	1.00	1.00	17	24 1/8	14	2.40	1.08 prov.
Braniff Airways		$ 2.50	2 948 119	0.60	0.60	9 1/2	11 1/2	6 1/2	0.64	0.60 e
Capital Airlines		$ 1	909 559	—	—	16 3/8	26 3/8	9 7/8	1.38 d	2.12 d (11 m.)
Eastern Air Lines		$ 1	2 921 337	1.00	1.00	38	51 3/4	27	5.17	3.20 prov.
Flying Tiger Line		$ 1	983 635	—	5 % [1]	6 7/8 [2]	10 1/8	5 7/8	0.16 d	0.67 d
KLM		Fl. 100	1 429 540	1.84	0.79	28 1/2	36 7/8	23 1/4	4.60	3.73 (9 mths)
National Airlines		$ 1	1 044 977	1.00	1.00	15 3/8	30	13 3/4	4.14	3.00
Northwest Airlines		$ 10	1 343 120	0.80	0.80	13	17 5/8	9 3/8	2.18	3.00 e
Pan American World Airways		$ 1	6 185 034	0.80	0.80	14 1/4	19 1/8	12 1/8	2.31	1.75 e
Seaboard & Western		$ 1	.	.	4 % [1]	6 1/2 [2]	17 3/8	7	0.31	0.49 (9 mths)
Trans World Airlines		$ 5	6 674 113	—	—	12 1/8	20 1/4	9 1/4	0.70 d	0.37 (9 mths)
United Air Lines		$ 10	3 461 708	1.50	0.50 + 7 % [1]	26 1/4	43 1/4	18 1/8	4.55	3.34 [3]

Remarks

* The main production of the individual manufacturers is indicated in Col. 2 by numbers:

① = Aircraft
② = Helicopters
③ = Guided Missiles
④ = Powerplants
⑤ = Electrical, Electronics
⑥ = Equipment
⑦ = Atomic industry
⑧ = Airships

[a] = adjusted to allow for changes in capital (share-splits, etc.). United Aircraft Corp. issued 1 new share for 5 old shares in November 1957. Other special issues: Boeing 4 % stock dividend, McDonnell 4 %, Vertol 10 %.

[d] = Deficit

e = Estimated

[1] Stock. [2] American Stock Exchange. [3] 12 months to September.

INTERNATIONAL MEETINGS AND CONFERENCES

April 7th-19th : WMO - 2nd Session of Regional Association V (South-West Pacific). Manila.

April 8th-10th : 8th International Symposium. Electronic Waveguides - Microwave Research Institute of Polytechnic Institute of Brooklyn. New York.

April 8th-11th : SAE - National Aeronautic Meeting. Society of Automotive Engineers, New York.

April 9th : ICAO - Rules of the Air, Air Traffic Services and Search and Rescue Division. Montreal.

April 9th-19th : ITU/CCITT - Committee of the General Plan for the Development of the International Network. Rome.

April 10th-11th : ATS - Annual Meeting of the Aeronautical Training Society. Washington.

April 14th-17th : ASME - Design Engineering Conference. Chicago.

April 14th-17th : RECMF - 15th Annual Radio Component Show, organized by the Radio and Electronic Component Manufacturers' Federation. London.

April 15th-17th : ASME - Metals Engineering Division Conference. St. Louis.

April 16th-19th : AHS - 14th Annual National Forum - American Helicopter Society. Washington.

April 16th-25th : RCEEA - Instruments, Electronics and Automation Exhibition - Radio Communications & Electronic Engineering Association. London.

April 17th-20th : IEE - Second Annual Technical Meeting - Institute of Environmental Engineers. New York.

April 21st : IATA - Traffic Conference 2 Agency Sub-Committee. Paris.

April 21st : ITU - 13th Session of the International Telecommunications Union. Geneva.

April 22nd : FI - Conference on « Space Medicine, the Human Body in Space » by Major David C. Simons. Franklin Institute, Philadelphia.

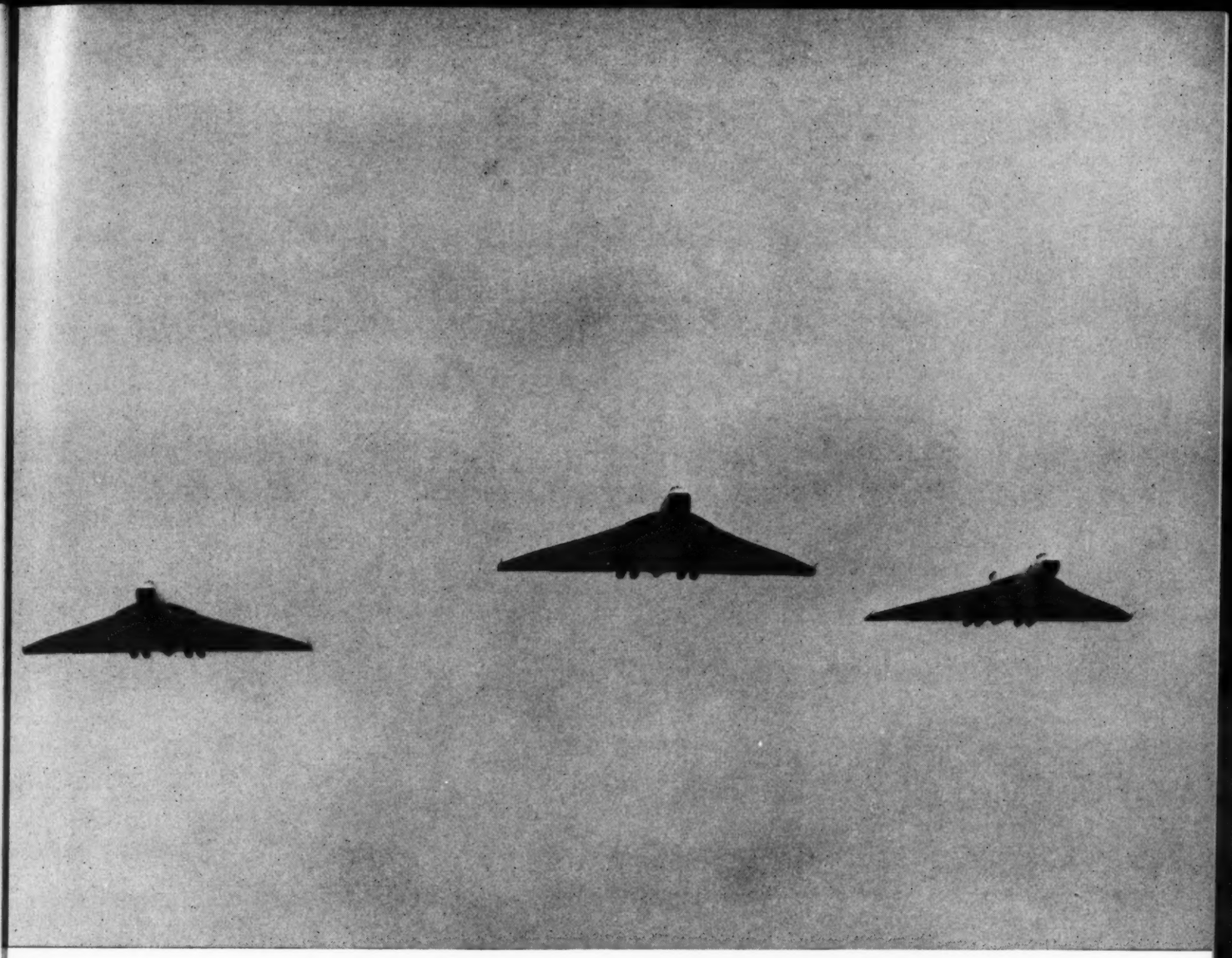
April 22nd-24th : Electronic Components Conference. Los Angeles.

April 22nd-24th : IANC - Annual Convention - International Airline Navigation Council. New York.

April 28th-30th : 2nd Annual Astronautics Conference sponsored by Air Force Office of Scientific Research, and Institute of Aeronautical Sciences. Denver, Colorado.

April 28th-May 3rd : Conference of the Engineering Societies USA - West Europe. New York.

April 29th-May 17th : WMO - 10th Session of the Executive Committee. Geneva.



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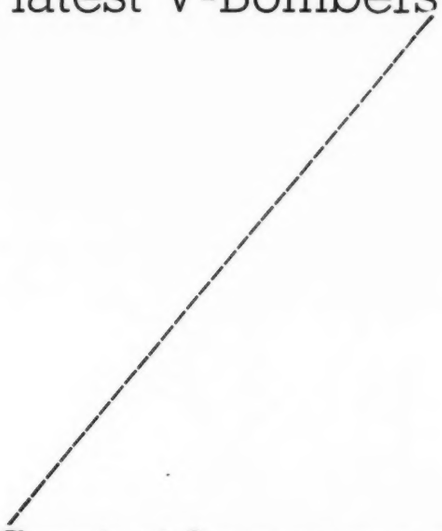

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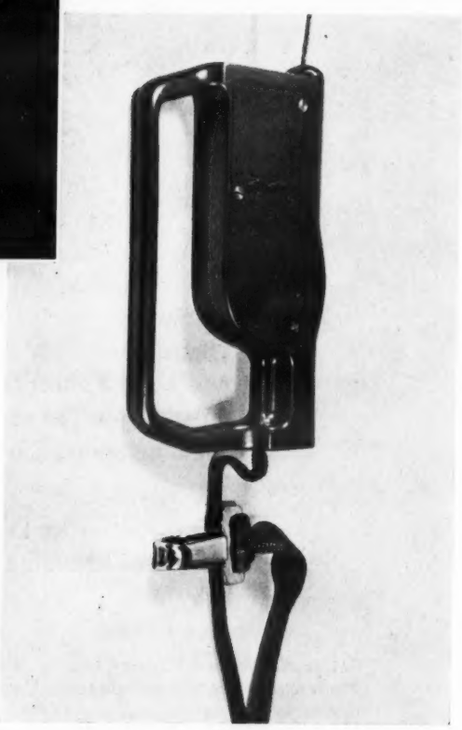

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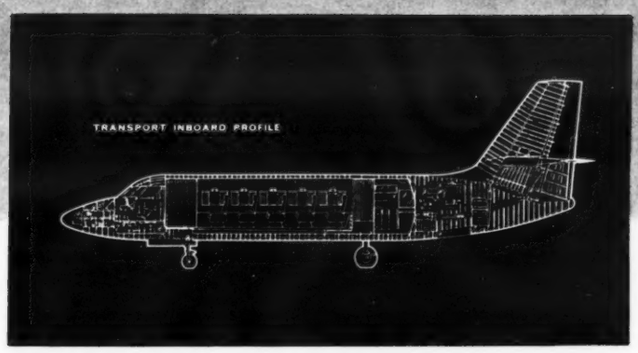

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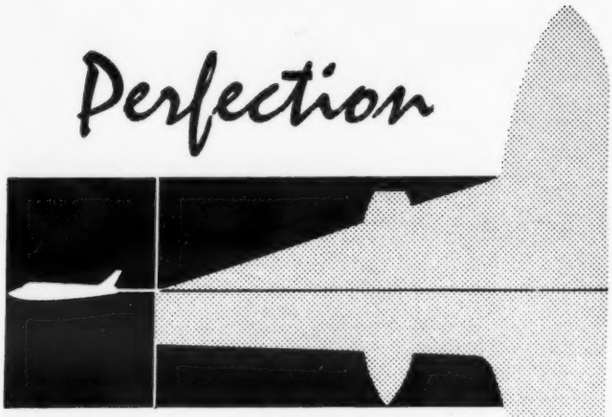

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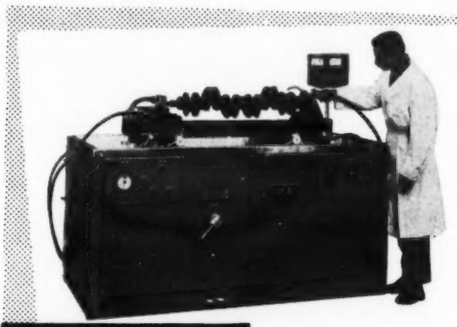

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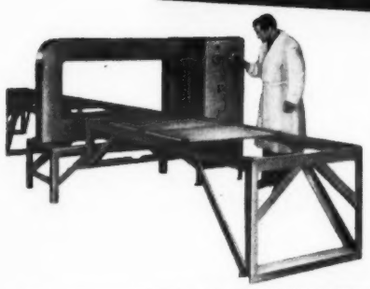

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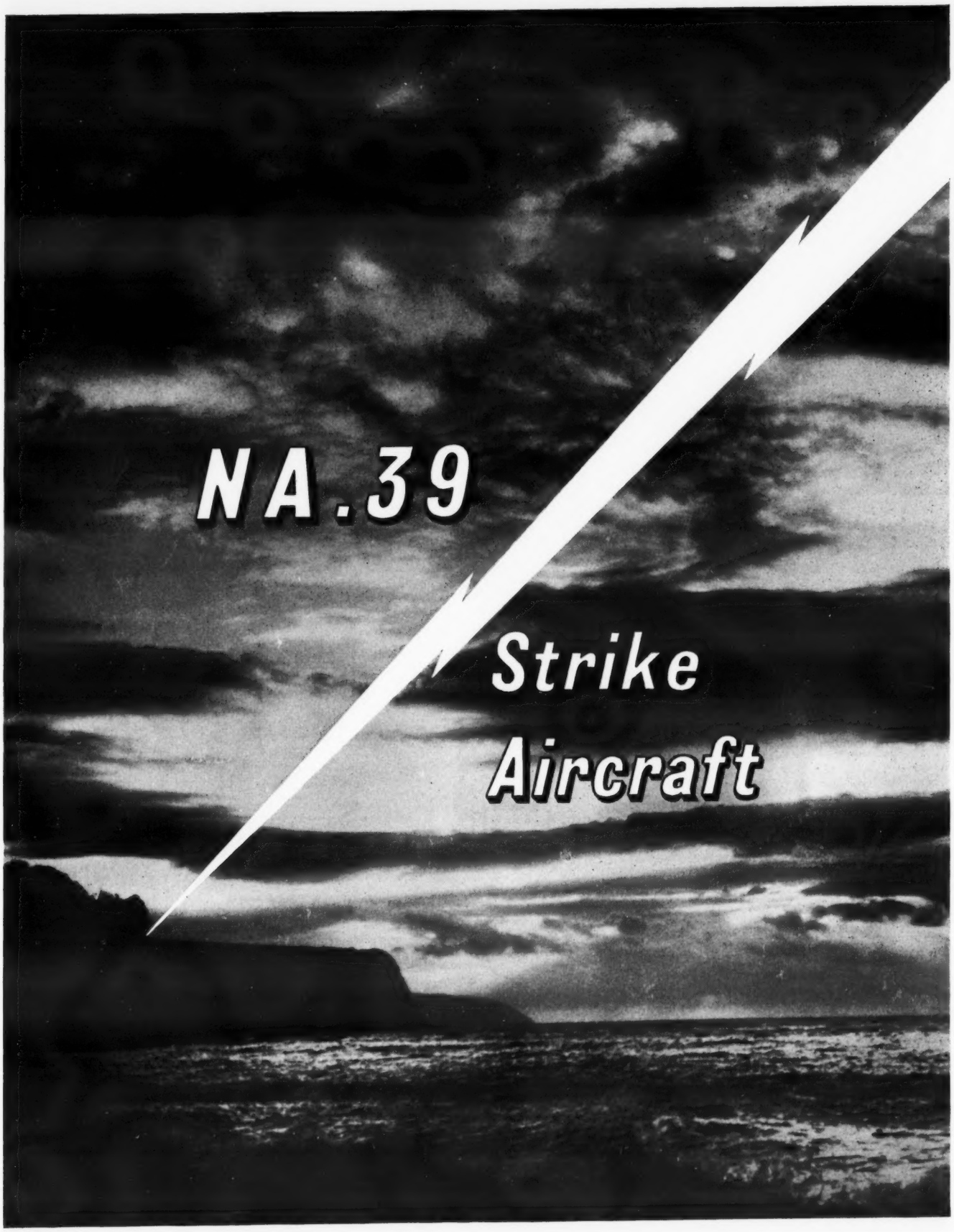

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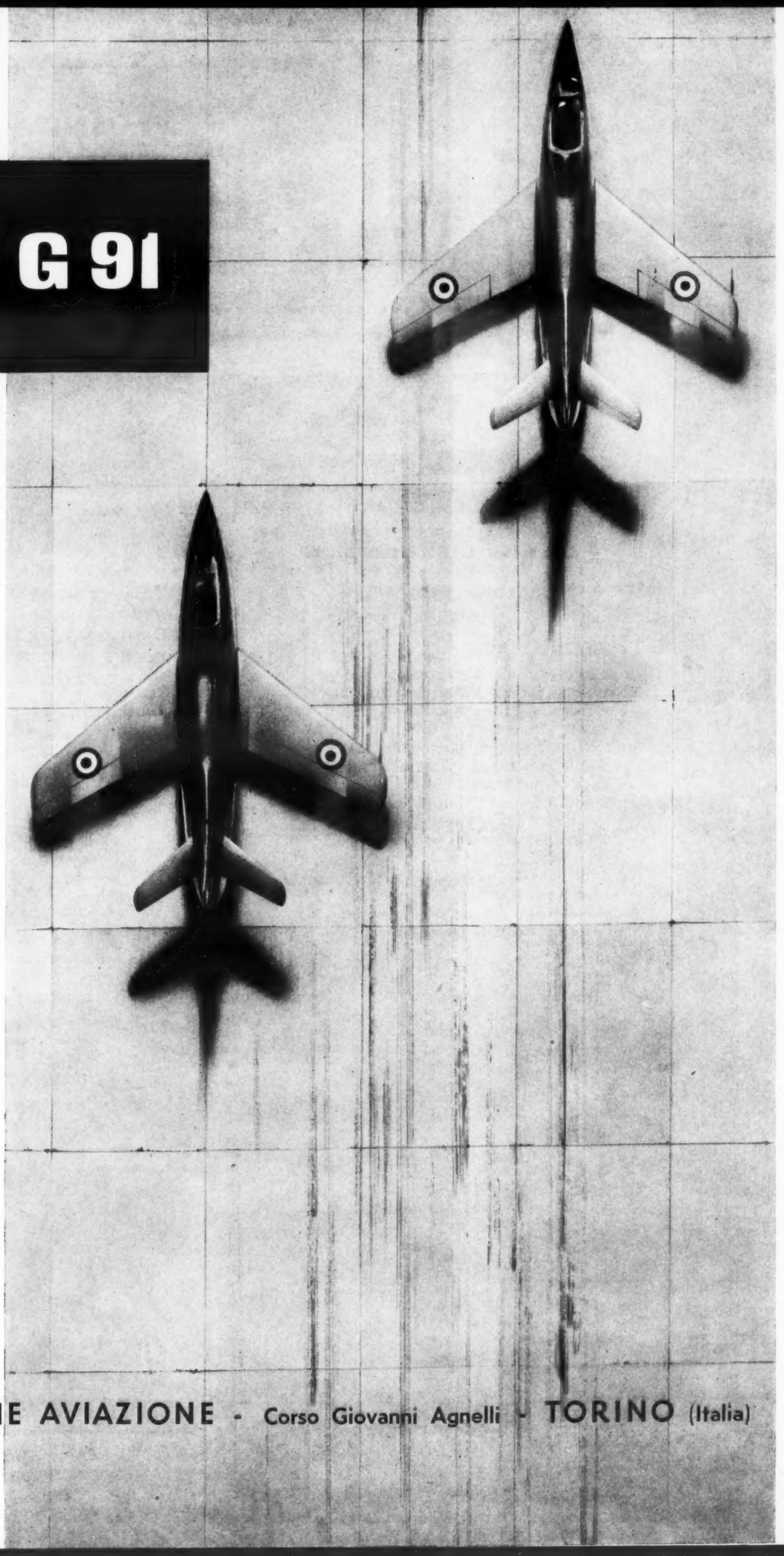

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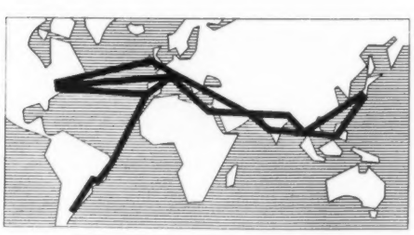

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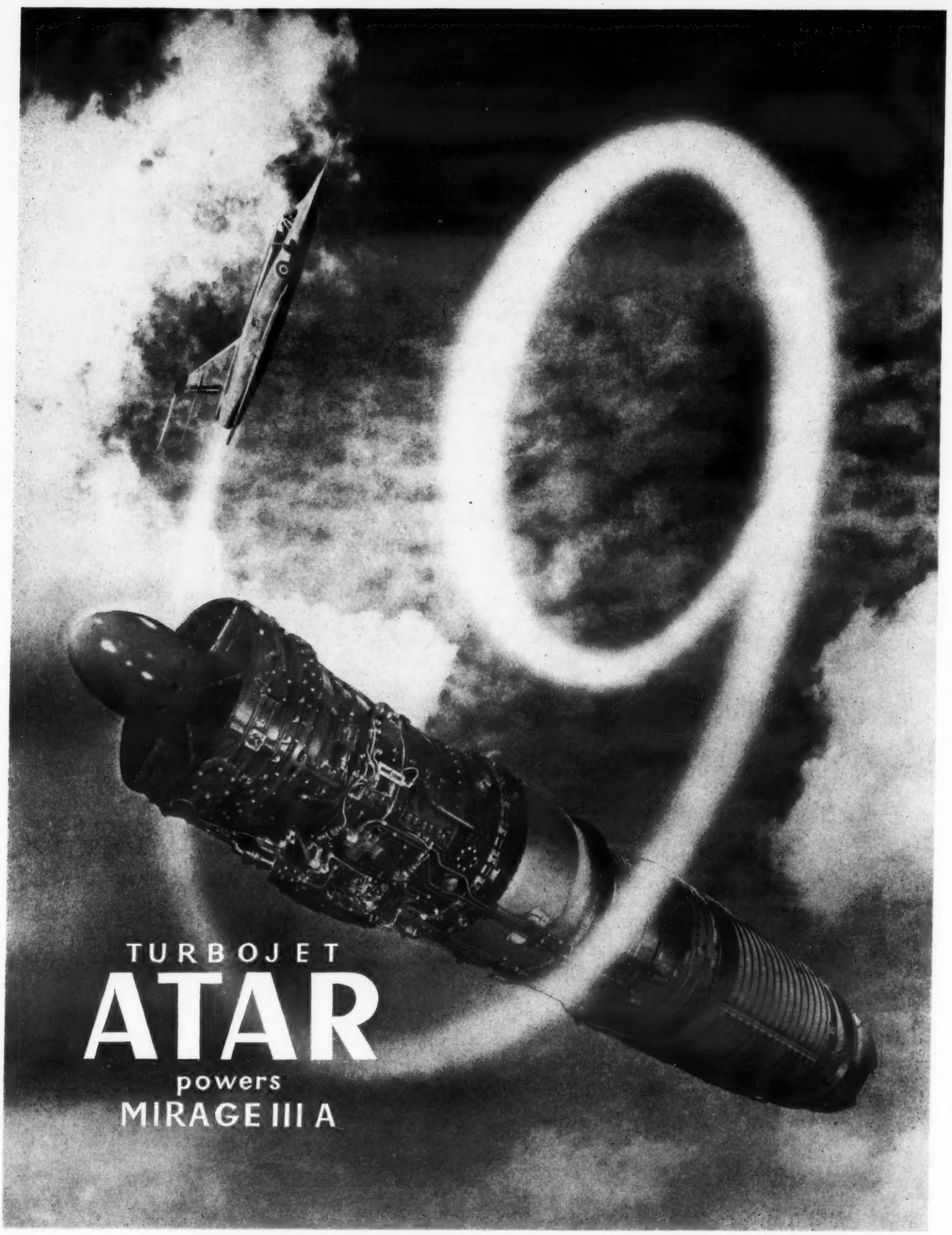

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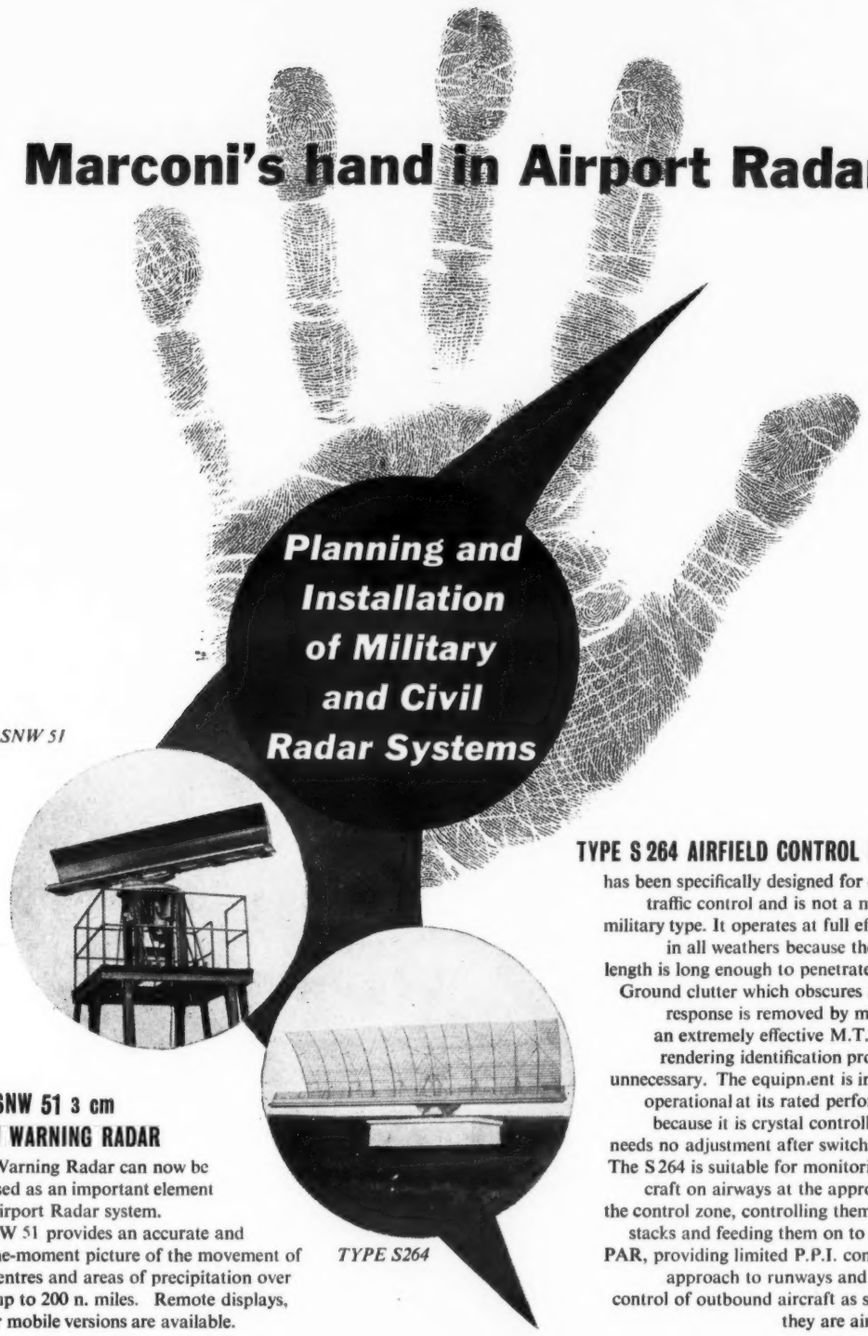

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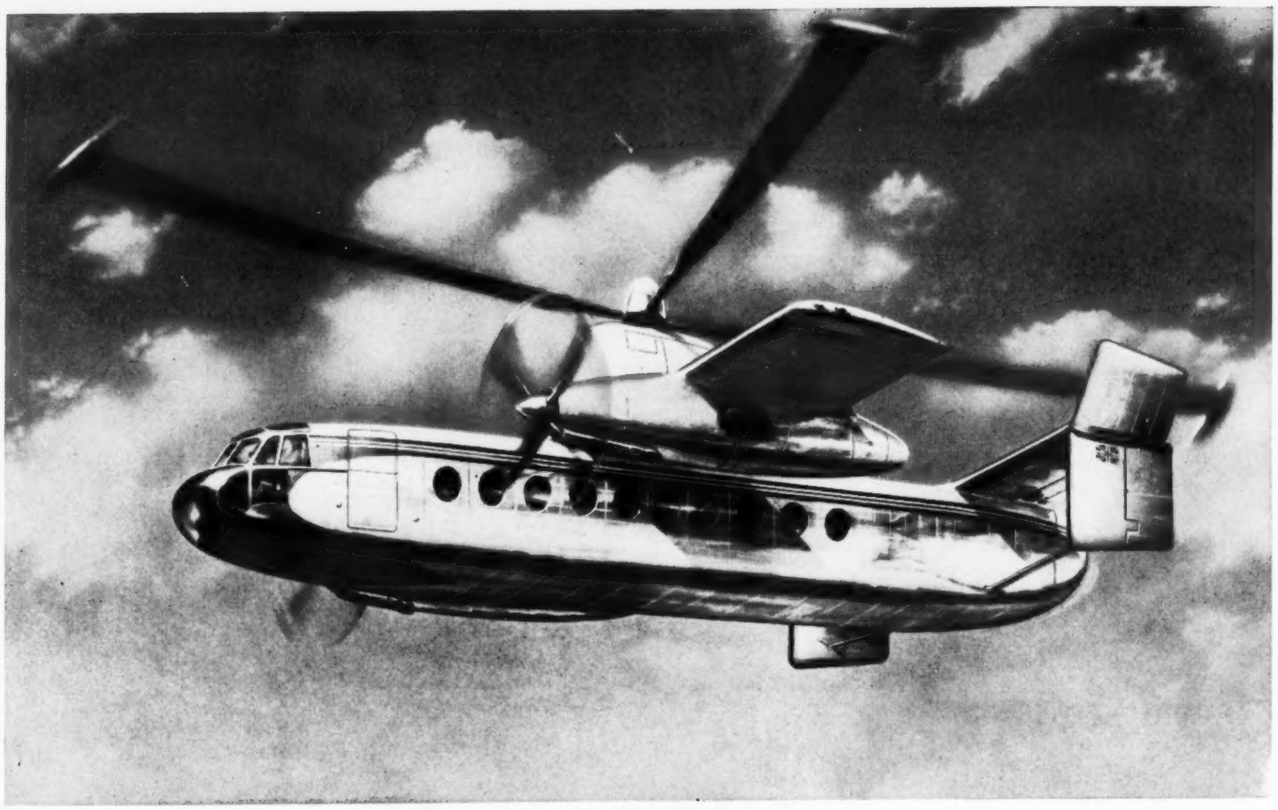

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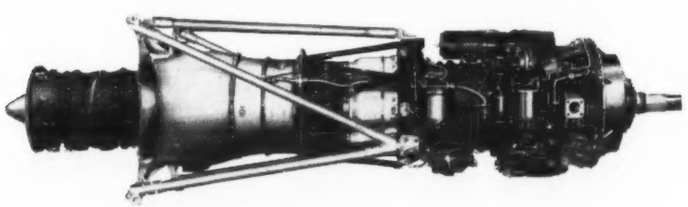

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Has the West Chosen the Right Weapons?

In days of old, hostilities were preluded by an exchange of abuse. Read, for instance, what "compliments" Homer puts into the mouths of his heroes, both Greek and Trojan, in the "Illiad"... Later the world apparently became a little more civilized. Prospective belligerents instructed their ambassadors to hand the future enemy a formal declaration of war, phrased in the politest of terms. The monarch thus challenged provided a safe conduct for the embassy staff and ceremonially prepared for battle. This practice continued until World War II. It will be remembered how often Hitler observed the Sabbath by using the weekend for a surprise attack, naturally without previous declaration of war, and the sudden Japanese blow on Pearl Harbor is engraved in the annals of American history for all time.

How a future war might start has been described by Dr. Pickering, of the California Institute of Technology. Radar equipment scans the airspace in all altitudes and over long ranges, and the moment a suspicious echo appears on the radar screen the alarm is given. Long-range bombers armed with H-bombs take to the air, launching ramps are loaded with their death-dealing missiles, and the course of the approaching enemy is plotted by an electronic brain. Everything is ready for the button to be pushed to unleash nuclear war... If just one electron tube failed, just one mechanical or human error occurred, the whole of mankind might perish because of an error of calculation. The constant mutual threat of atomic destruction has had its effect. Mankind has become almost hysterical enough to rush into nuclear war on a false alarm.

*

It was probably some such consideration as this which led Anthony Eden, then Britain's Foreign Secretary, to propose at the 1955 Geneva Summit Conference the creation of a demilitarized zone between West and East. This proposal has recently been followed by the so-called Rapacki Plan, which is attributed to the Polish Foreign Minister and is at present playing so large a part in Russian propaganda. The new plan calls for a denuclearized zone between West and East. Commenting on this proposal, the "Neue Zürcher Zeitung" writes: "... What does this plan mean, militarily speaking? It would create an arena for conventional weapons in Central Europe. As neither the United States of America nor Britain possess forces extensive enough to hold the field with traditional weapons, and as their armies can defend themselves only with the aid of the increased fire power provided by nuclear weapons, the two countries would be obliged immediately to withdraw their troops from this zone..." The writer of the article in the "Neue Zürcher Zeitung" evidently considered it impolitic to discuss the subsequent results of such a withdrawal. If the argument were carried to its logical conclusion, it would have to be recognized that the side attacked by overwhelming conventional weapons would be obliged to resort to atomic weapons.

Here we come to an impasse, and any country that argues that its defence can be ensured by atomic strength, with only a token conventional force, is deceiving itself. The last British White Paper on Defence ("Britain's Contribution to Peace and Security") published in February 1958 states under paragraph 38: "The strategic nuclear deterrent is the decisive factor in preventing major war. But it does not obviate the need for maintaining a substantial shield of land forces, with air and naval support, to defend the frontiers of the free world... A high proportion of Britain's military effort will therefore, of necessity, continue to go into forces of this kind." The expressions "decisive factor" for nuclear strategy and "high proportion" for conventional weapons are, however, somewhat elastic. Elsewhere in the White Paper it is stated that the West might retaliate with nuclear weapons even if the Soviet Union attacked Europe "only" with conventional weapons. And it is known that until very recently British defence planning called for sharp reductions in conventional weapons in favour of atomic arms. If such plans were carried through consistently, the "shield" of Western defence, firmly anchored in N.A.T.O. planning, would definitely be pierced.

*

In November 1957, Paul-Henri Spaak, then recently appointed Secretary General of N.A.T.O., addressed a small group of people in Paris on Eastern and Western thinking, and put forward the view that the East was confronted with the question of weapons or refrigerators, ...arms or a rise in the standard of living. The West had long answered the question for itself; it would have weapons *and* refrigerators, security and a high standard of living, with "business as usual". If Spaak's question is extended to the subject under discussion here, the answer for the West must obviously be *atomic weapons as a deterrent, plus conventional weapons on a large scale*—the answer which has already been adopted by the East.

All armed forces must be likened to a kind of fire brigade. The fire service does not turn out in full strength for a chimney on fire. Similarly, when local conflicts arise in some corner of the globe, as now appears to be the order of the day, it would seem to be somewhat hazardous to consider employing the ultimate weapon from the outset.

*

The subject of nuclear and conventional arms comes up for discussion in the present issue. A N.A.T.O. General, whose brilliant military career has just closed on his reaching retiring age, puts forward the view that even the use of tactical atomic weapons could lead to global nuclear war, that the step from a localized nuclear conflict to a nuclear world conflagration

The Eastern *bloc* is known to have a comprehensive arsenal of conventional weapons: helicopters landing 164 troops, 12 anti-tank guns, 4 anti-aircraft guns and 22 vehicles (Tushino June 1956).

is too easily taken. The General considers that it will never be possible to remove all causes of conflict and hence entirely eliminate local wars in one part of the world or another. And as the East is known to possess a wealth of conventional weapons, with which it could embark on a campaign, the article calls upon the West also to equip itself with conventional armies, to take their place alongside the nuclear deterrent in protecting the world from irreparable harm.

*

It is obvious that in peacetime the Americans cannot be expected to maintain vast armies on the European continent, capable of matching the Eastern masses man for man. It is also understandable that the British, with their far-flung Commonwealth commitments and their island location, should regard their units on the European continent merely as outposts.

Yet is is difficult to understand why the continental West could not draw level with the Eastern bloc in conventional weapons. Has not Western Europe a bigger population and a bigger industrial potential than the East? Or is it in any way intellectually inferior? The Western European military planners' most urgent task is to give the West's shield the strength it now lacks.

Comparative Estimates of Russian and American Strength with Particular Reference to Conventional Weapons

	Soviet Union	U.S.A.
Population	210,000,000	173,000,000
Home territory (sq. miles)	8,600,000	3,000,000
Number of major cities (over 500,000 pop.)	22	18
Total armed forces (men)	approx. 4,000,000	2,700,000
Army	approx. 2,400,000	900,000
Navy	approx. 800,000	825,000
Air Force	approx. 800,000	875,000
Armoured divisions (140 tanks each)	40	approx. 3
Mechanized divisions (80 tanks each)	35	—
Infantry divisions (50 tanks each)	90	9
Airborne divisions	10	3
Marines divisions	—	3
First line tanks (including reserves)	approx. 20,000	approx. 3,000
Second line tanks	approx. 15,000	approx. 6,000
Submarines	approx. 400	approx. 200
Small naval vessels	approx. 80	approx. 260
Destroyers	approx. 130	approx. 390
First line cruisers	27	approx. 65
Aircraft carriers (CVA, CVS, CVL)	—	37
Escort carriers (CVE)	—	approx. 60
Transport aircraft	approx. 2,000	approx. 3,000
First line interceptors	approx. 10,000	approx. 3,500 (Home territory)
Naval aircraft, fighter bombers	approx. 3,500	approx. 12,500
Tactical bombers	approx. 5,000	approx. 1,000
Medium strategic bombers (*Badger;* B-47)	approx. 500	approx. 1,400
Heavy strategic bombers (*Bison;* B-52; B-36)	approx. 300	approx. 450
Strategic tanker aircraft (*Bear;* KC-135; KC-97)	approx. 200	approx. 850

V. I. Lenin reviewing a parade of Soviet anti-aircraft tanks (Moscow 1957).

The Soviet Union has provided itself with a powerful air defence force: MiG-17 interceptors at an auxiliary airfield.

An Ilyushin Il-28 tactical bomber before take-off.

The fame of American arms, firmly established after the invasion of Europe in June 1944, has left its mark. The European armies reconstructed after the war not only wear uniforms of American cut, but are also in the process of building up armaments on the American pattern. This is a mistake, as the essential prerequisites are absent: money, space and the specialization which is one of the typical features of the American mentality, of the entire American economy. The Americans need considerably fewer conventional forces to defend their continent than do the Europeans, since not even in his wildest dreams could any Russian leader think of physically occupying the United States. The utmost he could do would be to threaten destruction, though all such threats would be boomerangs. But Europe is a different matter. It would not be the first time that Western armies overran Russian territory, or Eastern armies overran Western European territories. And to ward off attack by armies with conventional weapons, Western Europe also needs conventional weapons, a multi-purpose arms system, a fire brigade for both small and large outbreaks.

*

It is probably no accident that trilateral discussions should have been undertaken during recent weeks between West Germany, Italy and France, with the aim of coordinating the three countries' arms efforts. For the time being, none of these countries belongs to the so-called atomic club, and it would be entirely conceivable that the three young and energetic defence ministers should get together to fill in the increasingly dangerous gap in Western defences.

If Continental Europe can forge a shield of conventional weapons for the West, it will have made a decisive contribution to the security of the Western world and towards clearing the atmosphere. The West could no longer be accused of brandishing the atomic "big stick" on all occasions. Nor would the East be likely to unleash a war with conventional weapons, since it would inevitably be paid back in its own coin. To build up such a conventional European strength would be in the interest of the whole Western world; after all, the Americans cannot for ever play the part of Atlas, with the whole weight of the world upon their shoulders. *EEH*

World War Impossible, Local Conflicts Probable

By Pierre M. Gallois, Paris

Though the first to use nuclear weapons, the Western world has been unable and unwilling to exploit their full political significance. Yet since it has lost the atomic monopoly, the West has begun to attribute to the new explosive a power which it may never possess. Politicians and military, at any rate in the West, are behaving as if there were no relation between the capabilities of these weapons and the policies they make it possible to pursue. On this point the governments which are least dependent on public opinion reason the more clearly. As even the experts do not entirely grasp the implications of the present headlong evolution in arms techniques, it is clear that these implications will be unintelligible to the man in the street. During the past fifteen years there have been two major arms revolutions, followed now by a third of no less decisive importance:

- The nuclear explosive is now widely available. The "quantity of destruction" represented by the stocks of fissionable material reserved for military use far exceeds the political, human and even material "absorption capacity" of even the biggest countries.
- The explosive can now be housed in a relatively small volume, and modern projectiles weigh much less than the first bombs used. This form of "miniaturization" has far-reaching technical and military consequences: since the bomb can now be smaller and lighter, while still retaining its decisive destructive effect, it has given the light bomber the speed advantage which was formerly the privilege of the fighter. It has greatly reduced the value of a conventional defence organization in Europe, though less so in the United States, since distance will still confer advantages for a certain time to come. But above all, miniaturization enables the new explosive to be used in all sorts of carrier vehicles, from the static device such as the mine, to the ballistic missile hurtling towards its target at twenty times the speed of sound.
- The ballistic missile is now under development. This is the third of the great technical revolutions mentioned above, since it enables an all-powerful explosive to be allied with a carrier vehicle against which there is no defence today. Though the "association" of the nuclear explosive and the ballistic missile has at present no military value, it has had profound political repercussions. It has had the advantage of hastening the examination of the new strategic philosophy, but the disadvantage of appealing more to the imagination than to reason. The result is that the basic implications of the logic of this aero-nuclear age in which we live have not yet been generally accepted.

In the following paragraphs an attempt is made to define a number of undeniable techno-military facts, and to examine their strategic and political consequences.

1 Each of the great nuclear Powers possesses a tremendous destructive potential which they could assemble without tell-tale preparations.

During the T.N.T. age, massive destructive power could be obtained only by assembling a very large number of "carrier vehicles" (large land, sea and air units, each composed of a variable number of "carriers", from the infantryman with his rifle, to the aircraft carrier with its squadron of aircraft). War then had to be preceded by a period of rearmament during which the arms industries accelerated their output of weapons with a low unit power of destruction. This arms effort did not pass unnoticed. If the country or coalition threatened had the appropriate resources it could also progressively assemble the military forces to forestall an attack, to deter the would-be aggressor or at any rate to fight a defensive war without immediately being crushed by the aggressor. The final reckoning between the two nations or groups of nations was a *matter of time*. It took months or even years to change over from a peace footing—even in the case of an armed peace—to a war footing, and the efforts involved were sufficiently obvious to warn of the impending storm.

Since the advent of weapons with a high unit power of destruction the various stages of this gradual transition from peace to war have been remarkably speeded up. If a favourable conjunction of circumstances existed and in particular if one of the parties reduced its watchfulness, the other could deal it a mortal blow with only a minute portion of the forces it possesses today. This holds good whatever the power of the nations concerned, and it will in future hold good—again assuming a lack of watchfulness on the part of the country attacked—whatever the respective geographical positions of the future belligerents.

Each side has no doubt drawn up its own list of "alert criteria", i.e., has carefully defined the developments which would automatically trigger the precautionary measures designed to prevent recourse to force. But it still remains at any rate technically possible that an aggressor will be able to assemble all the conditions for a knock-out war, initiated by a surprise attack. *The success of the operation will depend on the permanent precautions taken by the victim rather than on the aggressor's preparations.*

2 The notion of "risk" has taken on a new sense. It has been radically changed by the existence of nuclear weapons.

The last two world wars were already total wars. But if nuclear weapons were employed, the extent of the damage inflicted, and hence the risk to be calculated in embarking on war, would be of quite a different order of magnitude. The

The West was the first to use nuclear weapons. The A-bomb explosion at Nagasaki, which put an end to Japanese resistance in World War II.

Today . . . hydrogen bombs of 20 megatons explosive effect. Britain detonated her first H-bomb near the Christmas Islands on May 31st, 1957.

Local conflicts require conventional weapons. During the Korean War the U.S. Navy operated mainly with carrier-based Douglas *Skyraider* attack aircraft (seen here without auxiliary tanks) and Chance *Vought Corsair* piston-engine fighters (with auxiliary tanks) . . .

. . . brought up supplies by means of "elderly" landing craft . . .

. . . and attacked ground targets with bombs and rockets released by carrier-based Grumman *Banshee* fighter-bombers . . .
. . . while the U.S. Army used conventional field guns and infantry weapons.

full significance of the "calculated risk" can be readily appreciated when it is remembered that the first few hours of operations would claim tens of millions of victims, as the U.S. authorities responsible for civil defence have pointed out.

Even more important, however, is that this "risk" would take on two new forms:

—The concept of gradual attrition of the adversary's potential and will to resist disappears. It is no longer a question of "absorbing" repeated blows, with the power of recuperation and adaptation that was still possible in the age of T.N.T. warfare. The heads of the attacking country would know that, if their initial operations missed their targets, if they did not succeed in immediately destroying their opponent's nuclear forces, they would have to possess impenetrable defences, or themselves suffer, a few hours later, a blow from which their country would no more be able to recover than the nation they had attacked. The risk which they would have accepted would thus have nothing in common with the risk involved in earlier wars. In conventional wars it was always possible to adjust a country's efforts to those of the enemy, by wider mobilization, new alliances, or the progressive introduction of new techniques. A country could raise itself to the enemy's level of efficiency and gradually reverse the initial balance of forces. Even if, at the outset, an aggressor had only a 55 percent chance of winning, his attack was still justifiable, at any rate militarily, since he had time to increase his margin of superiority. Today this prospect has disappeared. Either the initial operation succeeds, and the aggression pays off from the military point of view, or the initial operation fails and retribution is immediate. The "risk" becomes excessive.

—The second form of risk can be described as the "safe limit" for the utilization of nuclear weapons. Since the effects of blast and heat are further supplemented by immediate and long-term effects of radio-activity, nuclear weapons introduce a new concept of limitation which will play an important part in assessing the results of a possible nuclear war. If the victim of an attack has organized his forces in such a way that the attacker must have recourse to a large number of ground, or even underground, bursts, the danger of radio-active fall-out over long distances and long periods of time must also be taken into consideration. In this case the direct "boomerang" effect of an initial attack which failed even partially in its objects—essentially the destruction of the opponent's reprisal potential—would be supplemented by the indirect "boomerang" effect of contaminating the atmosphere. If a certain "safe limit" were exceeded, everyone would suffer, whether he were the victim or the aggressor. President Eisenhower announced last June that American physicists were about to produce "clean" bombs. "Give us four or five years of tests and we will build entirely clean bombs", said Edward Teller and Ernest O. Lawrence. The United States President gave it to be understood that it was possible to produce nuclear projectiles whose radio-active fall-out would be only 4 percent as dangerous as that of present bombs. But even if 96 percent of the fissionable material were neutralized, there would still be some sixty to eighty pounds of dangerous products released by the detonation of a single 20-megaton hydrogen bomb, or the equivalent of some 30 bombs of the type dropped on Japan. What is more, it is now learned that some of the substitute products which it had been planned to use to obtain "clean" bombs are themselves very harmful.

Quite apart from the genetic effects, of which there has not yet been time to acquire experience, the more immediate effects, such as those of strontium 90, have been studied throughout the world. The University of Columbia recently published the results of some of its studies: the quantity of Sr. 90 normally acceptable in the bones is not known, so that the safe dose had to be estimated. According to the physicists who have conducted the experiments, the present average concentration of Sr. 90 in the bones is very low and does not exceed five percent of the permissible dose, which has itself been calculated to give a wide margin. But in view of the half-life of strontium and the quantities already launched into space, humanity will have absorbed one fifth of the permissible dose by about the year 2,100. It is obvious that if the present test rate is stepped up into wartime use of nuclear weapons, the risk of exceeding the "safe limit" could be great. When planning his offensive operations, the would-be aggressor must allow for this risk and take into consideration the cumulative effects of not only his own "consumption" but also the projectiles which his attack would unleash against him. This new conception of "risk" is important. Fundamentally, it dominates the whole strategy for the nuclear age. The stake in a conflict would have to be absolutely vital to a country before it could take the risk of using the new weapons. Even then the risk is so tremendous that no aggressor could seriously think of accepting it if he knew that there was one chance in a hundred, or even one in a thousand, that his attack would trigger nuclear reprisals. But it is also clear that there can be trials of strength in which the two sides must agree in advance that the stake is not worth the risk inherent in the use of nuclear weapons. This was already true at the time when the West held the nuclear monopoly and when, for moral rather than material reasons, it voluntarily refrained from exploiting its crushing superiority. The shared monopoly means that the stakes would have to be higher, to justify the use of nuclear weapons. But if it is not clearly established that the nuclear arsenal will not be used, in other words if any doubt remains, then the risk may be considered too great, and the deterrent may retain its effectiveness.

3 Militarily speaking, the large-scale use of nuclear weapons would make sense only if the aggressor were certain of being able to destroy the victim's reprisal forces before having to suffer their effects.

The T.N.T. wars were based on a long exchange of blows, none of which were mortal in themselves but whose cumulative effects ultimately weakened one of the belligerents to the point of surrender. With nuclear weapons, even the first blow might be unendurable. Before a belligerent could deliberately use them, he would have to be certain of meeting one or other of the following conditions, or ideally both:

- the victim's reprisal forces would have to be destroyed before they were used:
- the aggressor would have to be sure that he could seal off his frontiers, both on the ground and in the air, so that the reprisal forces not destroyed by the first blow could not get through, or at least would be so decimated that their effects were endurable.

"In the strange logic of aero-nuclear strategy, a would-be aggressor could draw greater profit from a perfect defence system than from his offensive system." Red Air Force MiG-17 supersonic interceptors, with extra fuel tanks . . .

. . . and North American Air Defense Command Convair F-102A supersonic interceptors.

If the first of these two conditions could be met in full, the second could be ignored. Similarly, if the second were fulfilled, the first would become of secondary importance. Should an absolutely impenetrable defence system become technically possible, the aggressor's task would be greatly simplified. He would not need first to neutralize a large number of military targets (strategic air force bases today, ballistic missile launching sites tomorrow). It would then suffice to destroy a single city, since he could intercept all reprisals and thus deprive his victim of his aero-nuclear "punch".

It follows that, in the strange logic of aero-nuclear strategy, a would-be aggressor could draw greater profit from a perfect defence system than from his offensive system, whose efficiency would always depend on the defensive measures taken by his victim. It will be seen that this reasoning does not apply to a country which has no aggressive designs.

At the moment technology favours the offensive rather than the defensive, and an aggressor must base his operations on a combination of both offensive and defensive systems. His staffs would be required to make accurate calculations on the basis of uncertain premises: some of the enemy's reprisal forces would escape the surprise attack; would these forces, even when reduced by his defensive system, still be capable of inflicting a quantity of damage beyond his country's absorption capacity? If the answer were affirmative, the operation would be militarily unsound. If it were negative, the operation could be risked. But how could he be *sure* that his answer was correct?

Even if he possesses powerful offensive units, the aggressor knows that he would have little chance of successfully taking all his victim's reprisal forces by surprise on their widely dispersed bases. He therefore finds himself placed before the following alternatives: either he will attack the reprisal forces and, since he cannot destroy them all, must tolerate their effects; or he goes for his victim's cities, in which case he can perhaps deal him a mortal blow, but must be prepared to suffer a similar fate within a few hours. Hence there is today little sense, from the military point of view, in arguing that American cities are more vulnerable than Russian. It might be different tomorrow if the U.S.S.R. succeeded in establishing an impenetrable defence system. Joseph Alsop recently wrote* that within a few years the Soviets will have succeeded in mounting a defensive system capable of stopping practically all of the Anglo-American reprisal aircraft. If such a system were indeed available, and if the Soviets really took the risk of believing that it was in fact impenetrable, then they could direct their initial assault against the opponent's cities with impunity. But by this time the victim would also possess ballistic missiles, and an impenetrable anti-missile defence would be needed. We have not got to that point yet.

It follows from the above that, provided the necessary technical and financial effort is made, permanent neutralization of mass destruction weapons is possible—but only if the discrepancy in material forces is not too great and, above all, if the implications of the hydrogen age are

* New York Times, February 8th, 1958.

In the Indo-China war French airborne troops were flown to the front by Fairchild C-119 *Flying Boxcar* transports . . .

. . . and dropped by parachute over the fighting lines . . .

. . . followed by parachute drops of reserves and supplies (here on a rice field).

recognized sufficiently clearly to render blackmail ineffective.

4 The period of massive destruction would be at least as short as the period of direct preparation for aggression.

The rules are clear and cannot be broken. If by chance they were not observed, and the deterrent to large-scale aggression failed, the results would be a matter of mere speculation based on imagination or reasoning. It could then probably be argued that:

- organized fighting, if it occurred, would be very brief, since no organization and no political or social structure could resist such blows for long;
- the victim could not adapt his resources to those of the aggressor. If there were to be reprisals, they would have to be launched automatically;
- the conventional notions of military and industrial mobilization would lose their past significance;
- the problem of protecting the population and of fighting against panic and chaos would immediately take priority over military considerations. If the will to fight still existed, it would be on condition that the fighting be widely decentralized and take the form of guerilla warfare.

Suez: French Nord 2501 *Noratlas* transport dropping troops over the Canal Zone.

Noratlas squadron standing by on Cyprus.

Supplies for the French Suez units going aboard a Nord 2501 *Noratlas*.

Hydrogen logic and conventional dialectics

These arguments, carried to their extreme limits, have been thrashed out time and again by governments and their experts. The United States, followed with varying degrees of enthusiasm by its allies, has long been obliged to base the maintenance of the *status quo* on the threat of nuclear reprisals. But at the same time it has been agreed that conventional forces are also needed, in order to discourage even minor outbreaks. The cost will thus continue to be high. The normal tendency in the West is to attempt economies by basing defence plans on the new weapons. Two solutions are possible:

- a technical solution, consisting in making smaller forces more powerful with the aid of the new explosive;
- a political solution, consisting in the clear announcement that *any* form of aggression would be countered with nuclear weapons.

These two complementary lines of reasoning provide a solution to the economic problems rather than a satisfactory answer to the military problems. The first has the disadvantage of countenancing a start to the nuclear cycle. The second presupposes that all concerned would have the strength of character to resist the temptation to indulge in aggression, particularly of a minor nature.

As long as the West held an obvious advantage in the matter of explosive and above all in the means of delivery, a wide disparity in the conventional forces in being was of no great importance. The overall balance was too unequal, and the second of the two solutions described above was acceptable. This might not be so tomorrow. A new, paradoxical aspect of the rapid evolution in the balance of forces is that parity in aero-nuclear weapons entails a strengthening rather than a reduction in conventional forces. True, the risk taken by the aggressor is still too great for him to gamble on the reactions of his opponent's collective defence system. But if, through a succession of "feelers", he demonstrates the other side's reluctance to fight, presenting it with a choice between all-out nuclear war and piecemeal capitulation, there is not much doubt that he will win. Though a master card, the "atomic line" nevertheless has its limitations.

Defence is easy, attack difficult

The ballistic missile with hydrogen warhead will not invalidate all the above conclusions. It is easy to imagine a period marked by a degree of parity between the offensive missiles on either side, particularly as regards their qualities. It can also be assumed that this kind of balance will be achieved before operational counter-missiles are available on either side. The logic of ballistic-nuclear "exchanges", if they ever took place, would be similar to the logic of aero-nuclear exchanges, namely that the aggressor must first tackle his victim's reprisal resources, i.e. his missile launching sites. The side thus attacked, however, could direct its reprisals against the aggressor's cities. Or rather, to ensure that force shall not be used against him in the first place, he would threaten such action against any aggressor. We have reached the point where it is more important to render this type of warfare unthinkable than to make plans for meeting it. But in any case, the defender has the stronger position, provided he really possesses the requisite means of deterrence.

The terrifying reprisals he threatens would be against a relatively small number of cities forming vast static targets vulnerable to nuclear air bursts. Since he knows the location of these targets, since they are large, static and are sensitive to relatively low effects of blast and heat, only few missiles would be "consumed" in destroying them. Calculations reveal that even cities at a distance of 3,000 to 4,000 miles could be knocked out by from 4 to 12 missiles, depending on the latters' size (1 to 20 megatons). These figures apply only to the damage caused by blast.

If, as Camille Rougeron first suggested, a high altitude explosion and the resulting thermal effects were used, the above figures would be excessive. And it is known that, for targets of this kind and with bombs in the megaton range, the greatest damage would indeed be caused by heat.

The task of the attacker, however, would be vastly complicated if his victim possessed missiles dispersed among well protected launching sites. If these platforms were underground—as proposed in the British White Paper for Britain's future medium-range missiles—and if ground, or even underground, bursts had to be envisaged in order to cope with them, the "consumption" of attacking missiles would be considerable. A similar calculation to the above gives figures ten to twelve times as high. And this is assuming that the precise location of the targets is known, a problem which is obviously very much easier to solve for a city than for virtual point targets such as launching ramps.

It follows that the greater the number of dispersed or underground launching sites the defender possesses, the more effective will be the deterrent to aggression. But if the rules of the game were not observed, and the threat of reprisals were ignored, the latter could be effectively carried out with a small proportion of the missiles initially deployed. The aggressor, on the other hand, would have to mobilize a tremendous arsenal and be capable of using it all virtually simultaneously. As will be seen, the defenders would have unique advantages.

The Effects of Nuclear Explosions

By Interavia Study Group

The U.S.A.F.'s North American F-100 *Supre Sabre* fighter-bombers can carry tactical atomic bombs and are equipped for in-flight refueling. A single sortie of aircraft with this type of armament would have the same effect as a hundred World War II sorties.

As is well known, the nuclear explosive produces not only the blast and heat effects familiar since the introduction of gunpowder, but also effects of radiation. By and large, the energy generated by a nuclear explosion is distributed as follows:

Blast	50%
Heat	35%
Initial radiation	5%
Residual radiation	10%

These figures apply to explosions occurring in the lower layers of the atmosphere, where the air is sufficiently dense to play a role in the phenomena following on the explosion. The relative proportions of blast and heat in the energy yield vary with the altitude of the explosion. If the latter occurs in a rarefied atmosphere, the air is not sufficiently dense to transmit the shock wave, and the blast effect is greatly reduced. On the other hand, the energy normally transformed into a shock wave is transferred into thermal energy. Within certain limits the heat effect of an explosion at high altitude will increase from 35% of the total energy released to a figure nearer 85% (i. e. 35% plus the 50% of the energy normally transformed into blast).

Heat effects

An analysis of the military effects of atomic and hydrogen explosions reveals that up to medium powers, taken here for the sake of simplicity to mean kiloton bombs, blast will have greater effects than heat. On the other hand, thermonuclear projectiles from 1 megaton upwards are militarily more to be feared for their heat than for their blast effects. The latter decrease with altitude, while the radius of the zone affected by heat increases. It follows that a certain degree of inaccuracy can be accepted and that, when the thermonuclear explosive is used in conjunction with a ballistic missile, the "consumption" of these missiles could be very low if the target were vulnerable to heat effects.

The book published last year by the United States Atomic Energy Commission[1] is silent on the subject of these special conditions of utilization, but it does furnish sufficient information on the quantity of heat released by a nuclear explosion to enable the effects of a high-altitude burst to be evaluated.

The radius of the fireball obviously varies with the power of the explosion, ranging from some 150 ft. for an explosion equivalent to one kiloton, to 10,000 ft. for 20 megatons, by way of the following values:

20 KT	650 ft.
100 KT	1,300 ft.
1 MT	3,300 ft.

The quantity of heat recorded is naturally a function of the energy of the explosion, the distance (it varies in inverse proportion to the square of the distance) and the state of the atmosphere. The burns caused by the thermal rays vary according to the duration of emission of the heat, the angle at which it is received, etc. The following figures give the magnitude of the thermal effects for selected distances[2] and bomb power (page 312).

[1] "The Effects of Nuclear Weapons," edited by Samuel Glasstone, prepared by the United States Department of Defense and published by the United States Atomic Energy Commission, June 1957.

[2] Slant distance in metres from the point of explosion.

Atomic weapons for land warfare: The U.S. Army's *Corporal* surface-to-surface guided missile.

Atomic weapons for land warfare: The U.S. Army's atomic field gun (calibre 280 mm) has a range of up to twenty miles and can fire either conventional or atomic shells.

Multi-purpose armament?

N.A.T.O.'s Long-Range Bombers and Tankers

(Summer 1959)

Approx. 450 heavy jet bombers:

BOEING B-52 Stratofortress (U.S.A.F.)
Speed = 570 kn
Range = 6,000 nm + △R
△R = Extra range of the bomber after single in-flight refuelling

Approx. 120 jet tankers:

BOEING KC-135 Stratotanker (U.S.A.F.)
Speed = 500 kn
△R = 1,600 nm

Approx. 1,250 medium et bombers:

BOEING B-47 Stratojet (U.S.A.F.)
Speed = 540 kn
Range = 3,200 nm + △R

Approx. 50 medium jet bombers:

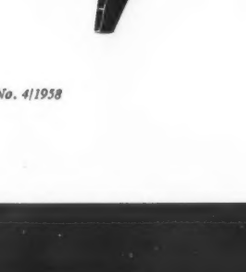
HANDLEY PAGE Victor (R.A.F.)
Speed = 570 kn

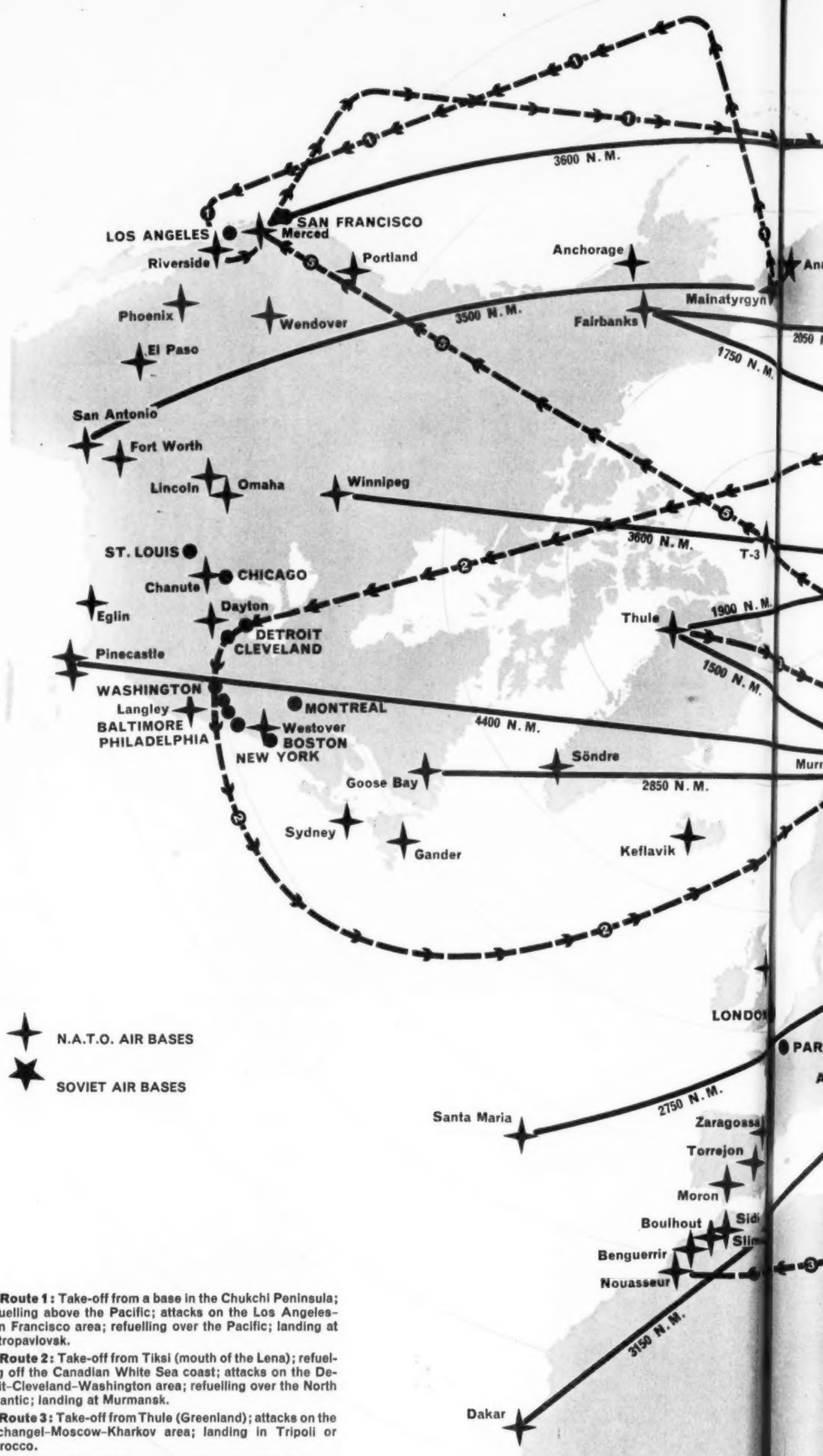
Approx. 50 medium jet bombers:

AVRO Vulcan (R.A.F.)
Speed = 570 kn

Approx. 100 medium bomber/tankers:

VICKERS-ARMSTRONGS Valiant (R.A.F.)
Speed = 510 kn
"Buddy" refuelling





N.A.T.O. AIR BASES

SOVIET AIR BASES

Route 1: Take-off from a base in the Chukchi Peninsula; refuelling above the Pacific; attacks on the Los Angeles–San Francisco area; refuelling over the Pacific; landing at Petropavlovsk.

Route 2: Take-off from Tiksi (mouth of the Lena); refuelling off the Canadian White Sea coast; attacks on the Detroit–Cleveland–Washington area; refuelling over the North Atlantic; landing at Murmansk.

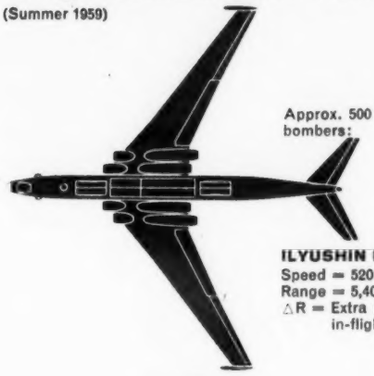
Route 3: Take-off from Thule (Greenland); attacks on the Archangel–Moscow–Kharkov area; landing in Tripoli or Morocco.

Route 4: Take-off from Kano (Nigeria); refuelling over the Red Sea; attacks in the Tashkent area; landing in Okinawa.

Route 5: Take-off from Dharan (Arabia); attacks on the Sverdlovsk area; refuelling over Northern Canada; landing in the United States.

The Soviet Union's Long-Range Bombers and Tankers

(Summer 1959)

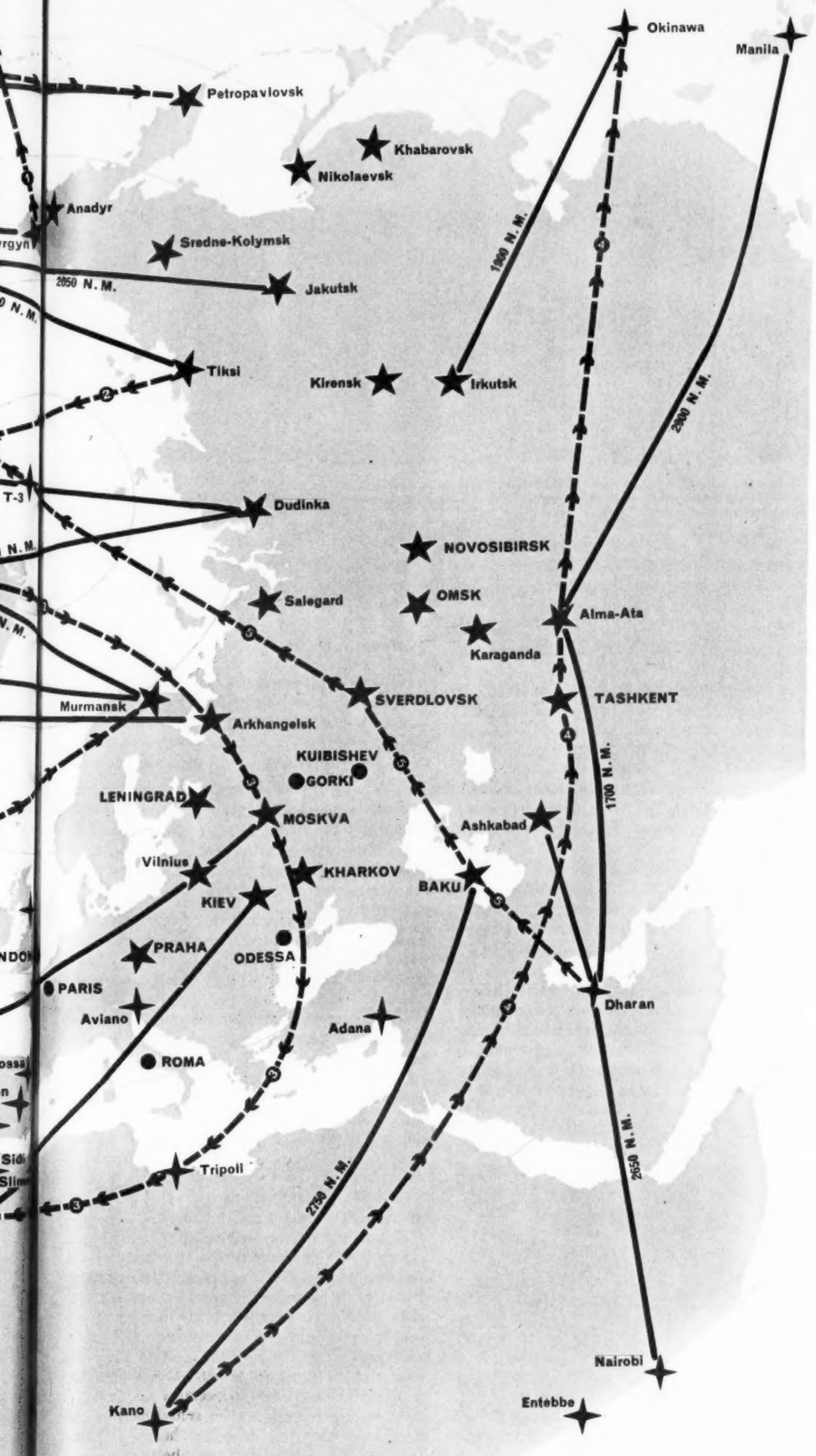


Approx. 500 heavy jet bombers:

ILYUSHIN Bison
Speed = 520 kn
Range = 5,400 nm + △R
△R = Extra range through in-flight refuelling

Approx. 200 heavy turbo-prop bomber/tankers:
TUPOLEV Bear
Speed = 485 kn
Range = 7,000 nm

Approx. 500 medium jet bomber/tankers:
TUPOLEV Badger
Speed = 500 kn
Range = 3,200 nm + △R
△R = 1,000 nm
△R = Extra range through "buddy" refuelling



AERONUCLEAR STALEMATE:

The accompanying map of the Northern Hemisphere shows only the best known strategic bomber bases on both sides and indicates a number of characteristic distances (in nautical miles). The total number of S.A.C. strips is estimated at 80, roughly half of which are situated on the North American continent. The Soviet long-range bomber fleet probably has a roughly similar number of strips. The map also shows the 12 largest cities in the Soviet Union and in North America, and a number of European major cities (place names in capitals).

As will be seen, the heavy bombers of both sides can attack any strategic target in the opponent's home territory with one (or perhaps two) in-flight refuelling and—provided they are not shot down—return to their own bases. Five of these possible routes for heavy bombers are marked in the map as examples.

The medium jet bombers o ‹both sides would probably, in the event of war, be used primarily for attacks on enemy bases in the Arctic and in the areas near the fighting line. Their range or radius of action (with one in-flight refuelling) is sufficient for these tasks. From the summer of 1959 onwards an increasing number of medium-range rockets (United States *Thor* and *Jupiter* and their Soviet counterparts) would be available for similar missions.

The bases are so widely dispersed that absolutely simultaneous attacks on all the opponent's bases would be impossible, and a surprise attack would bring no decisive advantages; at any rate it could not prevent the enemy from sending off his own bombers. The success of the first bombing operations on either side would depend primarily on the relationship between attacking and defending forces (saturation of defence); the larger the number of bombers penetrating the enemy air space at a given time, the greater the chances of success. Even with the most efficient air defence system, the first bomber wave would inflict very serious damage on each of the two main opponents. The outcome of the conflict, however, would be decided by the subsequent "waves" of surviving aircraft and the operations of land and naval forces.

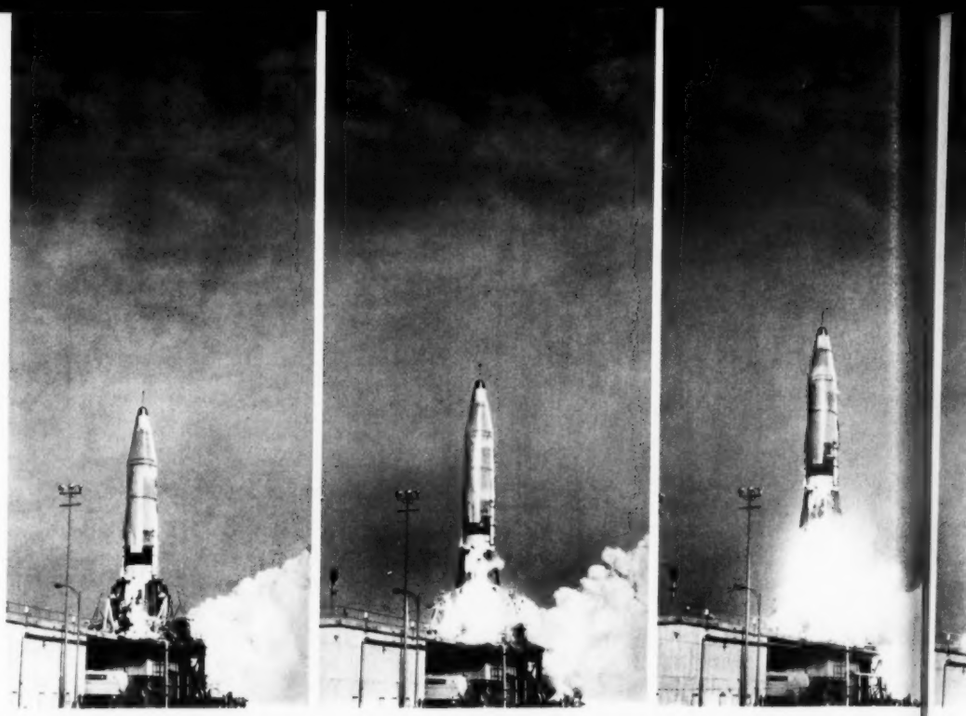
Multi-purpose armament?

Heat in cal./sq.cm	Power of bomb				
	10 KT	20 KT	100 KT	5 MT	20 MT
3	2,500 m	3,300 m	7,150 m	42,000 m	75,000 m
12	1,250 m	2,000 m	4,000 m	22,500 m	30,000 m

What do 3 cal./sq. cm and 12 cal./sq. cm correspond to in practice? Measures made at Hiroshima, Nagasaki, Bikini and in Nevada show that:

- 3 to 4 cal./sq. cm causes partial charring of dry wood, such as telegraph poles. Newspapers exposed to the thermal wave will catch fire. 4 cal./sq. cm would produce second degree burns in the case of a 1-kiloton projectile;
- 10 to 12 cal./sq. cm sets cardboard and most fabrics on fire, as well as more generally all materials described as combustible (for example, a wooden chalet would be severely blackened, or might even catch fire).

The above figures probably do not apply to high-power air bursts. Nevertheless they do reveal that a 20-megaton projectile could cause serious fires at slant distances of up to 20 miles. With bombs of higher power exploding at altitude, this distance might be more than doubled.



Atomic rocket stalemate: As soon as both sides have adequate stocks of intercontinental ballistic missiles with atomic warheads (not before 1960), total atomic war will become pointless, as there would be no means of stopping the victim's devastating reprisal blows.

Blast effects

The effect of blast is to create an overpressure at the front of the shock wave, through the expansion of gases suddenly raised to very high temperatures by the explosion of the projectile. It should be noted that the shock wave is reflected when it encounters a denser medium (surface of the earth or the water) and that the reflected wave intermingles with the original shock wave. It has also been found, for example, that if there is a temperature inversion and a high-level layer of air forms a screen, the blast wave will ricochet between the earth and the reflecting layer, thus carrying some of the energy yielded by the explosion over very great distances.

The effects of the blast wave are expressed in pounds per square inch of overpressure. The following are examples of overpressure at various distances from ground zero and for various explosion powers, in round figures:

p.s.i.	1 KT	20 KT	100 KT	5 MT	20 MT
1.4	1,500 m	4,000 m	7,000 m	25,000 m	40,000 m
5	700 m	2,000 m	3,250 m	12,000 m	20,000 m
7	500 m	1,500 m	2,500 m	9,000 m	15,000 m
14	300 m	800 m	1,300 m	5,000 m	8,000 m
28	100 m	300 m	500 m	2,000 m	3,000 m
42	60 m	200 m	260 m	1,400 m	2,000 m

What do these overpressures mean? Experience shows that an overpressure of 14 p. s. i. will seriously damage all conventional installations and structures. A classification of damage sustained reveals the following picture:

- Complete destruction of modern buildings (cement, metal structure, concrete) except specially designed shelters 21 to 28 p. s. i.
- Moderate destruction of the above and complete destruction of lighter installations (brick, for example) . . . . . 5 p. s. i.
- Limited damage to buildings of the first category, but necessitating large-scale repairs before re-use . . . . . 3.5 p. s. i.

The tests carried out in the Pacific and in Nevada have enabled the blast effects due to nuclear explosions to be checked.

In Japan it was found that overpressures of less than 21 p. s. i. were sufficient to demolish modern metal-frame buildings with cement walls. Overpressures of 18.5 p. s. i. at 10,000 ft. from ground zero caused serious damage, such as collapsed or split walls, and doors and windows torn out. At the other end of the scale, however, an overpressure of 15 p. s. i. caused no damage to machine tools, though the latter risk damage from the flying debris of all kinds which accompanies the nuclear explosion.

The Nevada tests revealed that overpressures of 1.4 to 2.8 p. s. i. knocked out aircraft parked in the open. Ships in harbour, on the other hand, do not sustain heavy damage from air bursts until overpressures of 7 to 13 p. s. i. are recorded.

The policy of placing launching sites underground, as forecast in the recent British White Paper, raises the problem of surface or underground bursts. The Atomic Energy Commission's book suggests that deep underground bursts are not envisaged, since the effects of surface bursts would suffice, in view of the large craters they form. Britain's announcement of plans for underground missile sites, however, will probably lead to more detailed study of the problems of deep underground explosions.

Surface bursts, in which the fireball touches the ground, form craters whose size is proportional to $\sqrt[3]{P}$, where P is the power of the bomb. Correction factors must be applied if the ground is hard and rocky, for example.

Around the crater itself is a so-called rupture zone, whose radius is one and a half times the radius of the crater. Beyond this again is the plastic zone, in which the soil is permanently deformed. The diameter of this zone, which like the rupture zone is partially covered by earth falling back from the crater, is about twice the diameter of the crater.

The overall effects of underwater bursts are measured by the same formulae as are used for air bursts.

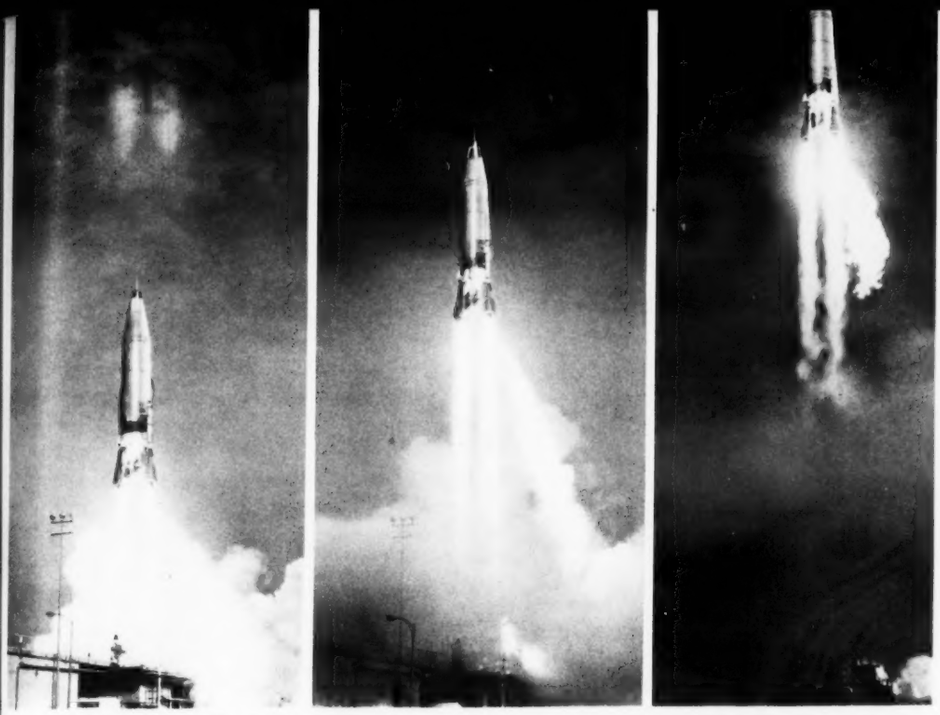
Radiation effects

For practical purposes, nuclear radiation effects are divided into two categories, namely initial radiation occurring within one minute of the explosion, and residual radiation occurring later:

- The initial radiation consists of most of the neutrons and a certain proportion of gamma rays.
- Residual radiation basically includes the beta particles and the remainder of the gamma rays.

In the case of an air burst, alpha and beta particles play a minor role, and the initial radiation contains chiefly gamma rays and neutrons. Their damaging effects are well known.

Three types of radio-active fallout can be listed in the case of an air burst: immediate fallout roughly vertically beneath the point of explosion. If the fireball does not touch the ground this type of fallout can be regarded as insignificant from the point of view of the damage it causes. If, however, the ball of fire does touch the ground it projects into space a large quantity of radio-active debris which falls back to earth in an area roughly elliptical in shape; the longer axis of this ellipse increases with the power of the explosion and the strength of the winds in the lower layers of the atmosphere. This constitutes the second category of fallout. The third comprises the radio-active particles which are thrown up to very high altitudes by the explosion and later fall slowly back to earth. A certain proportion of these particles, namely those which do not rise beyond the tropopause, is brought down again by rain. The remainder which rises above the tropopause to the stratosphere falls much more slowly, and the fallout from an explosion may continue for several years.



At present ICBMs on both sides are still in the experimental stage and still have many difficulties to overcome. Pictures show the successful launching of a Convair *Atlas* from the U.S.A.F.'s Cape Canaveral rocket centre (January 10th, 1958) using the thrust of two of its three rocket motors.

As a general rule it can be said that atomic bombs send only a part of their radio-active dusts into the troposphere and that all this fallout will be brought back to earth by rain and clouds.

Thermonuclear bombs, on the contrary, project a large proportion of their radio-active particles into the stratosphere, where they travel for years, gradually descending into the troposphere. Here they suffer the same fate as the particles from an atomic explosion.

This is the cycle followed in particular by strontium Sr. 90, the effects of which on human beings (cancer of the bones) can be very serious. However, the strontium so far projected into space by the various American, British and Russian atomic tests is far below the maximum permissible dose, as estimated by the physicists.

*

The normal unit of measure used for *gamma radiation* is the roentgen, which expresses the intensity of radiation received at a given point. The dose received decreases as the distance from the source, i. e., from the explosion, increases. There are two reasons for this:

- the dose received is inversely proportional to the square of the distance;
- the effects are attenuated by the atmospheric absorption and the diffusion of the gamma rays.

The following table gives three values for the initial gamma radiation, for selected distances and energy yields of nuclear projectiles:

Dose in roentgens	Power of explosion in kilotons (KT) and megatons (MT)			
	20 KT	100 KT	1 MT	20 MT
100	1,500 m	2,400 m	2,750 m	4,500 m
300	1,250 m	1,720 m	2,550 m	4,150 m
1,000	1,050 m	1,350 m	2,200 m	3,600 m

Radiation effects can also be attentuated to a certain degree by shielding materials. The table below gives the required thickness of five materials or products to stop half of the initial gamma rays.

	Thickness required to halve absorption
Steel	1¼ ins.
Concrete	6 ins.
Earth	7½ ins.
Water	13 ins.
Wood	23 ins.

The *neutrons* released by a nuclear explosion represent only 0.025 percent of the total energy yield of the explosion. Nevertheless, these neutrons can have very dangerous effects. Roughly 99 percent of the neutrons are released during the thousandth of a second following the explosion, with the remaining 1 percent being emitted later.

It is more difficult to protect oneself from neutrons than from gamma rays. Experience shows, however, that a thickness of 20 inches of concrete will in practice stop a large proportion of the neutrons.

*

Even pure defensive weapons with atomic warheads, such as this U.S. Army *Nike Hercules* anti-aircraft rocket, would contribute to radio-active contamination in the event of war.

There then remains the *residual radiation*, which is defined as the radio-active effects beginning one minute after the nuclear explosion.

Fission products are very numerous and include some 200 isotopes of 35 elements, whose radio-activity is initially very great but decreases in time. It is estimated that about 1¾ ounces of fission products are formed for each kiloton of fission energy yield (or 110 pounds per megaton). It has been calculated that if the fission products of an explosion of 1 megaton could be uniformly spread over an area of 10,000 square miles, the intensity of residual radiation twenty-four hours later would still be 2.7 roentgens per hour at a level of 3 feet above the ground.

Radio-active intensity decreases rapidly, and after 24 hours is only 1/6,000 of its value after one minute. For every seven-fold increase in time after the explosion, the activity decreases by a factor of ten. For example, at the end of one week, the radiation will be one-tenth of the value after 1 day.

Atmospheric conditions, the altitude of the explosion and its energy yield determine the shape of the zone contaminated by the explosion of a nuclear projectile. Theoretically, this zone includes:

- a circular zone centred roughly on the vertical at the point of explosion;
- an elliptical zone passing through the point of explosion; the relation between the longer and the shorter axis depends on the atmospheric conditions.

Obviously ground or semi-underground bursts will produce the greatest amounts of residual radiation. On the other hand, if the explosion takes place deep underground, the fission products do not reach the atmosphere, and the explosion will be "clean". In any case, the deeper the explosion, the smaller is the contaminated zone around it, so that it can be argued that the projectile can be described as clean when it explodes in the ground at an adequate depth.

An under-water explosion yields results comparable to those of an underground explosion, with one important difference: radio-activity in the water is gradually dispersed, while it persists in the soil.

What are the effects of radiation on man?

Survival after overall exposure to a dose of 700 roentgens is practically impossible. A person exposed to a radiation dose of 300 to 500 roentgens might escape death, while survival is probable for doses between 100 and 250 roentgens. This is the radiation intensity to which the Japanese fishermen were exposed in March 1954. Between 25 and 100 roentgens, radio-activity has relatively minor effects which are always curable.

As regards long-term radio-active effects, the product most feared is strontium 90, since its half-life is 28 years. Because of this long half-life, Sr. 90 can accumulate in the skeleton and ultimately exceed the permissible dose. In this case it would have the same effects as the plutonium released on fission. The half-life of plutonium is still longer than that of strontium 90, and its radio-activity therefore decreases even more slowly. Like radium, plutonium in the form of alpha particles can cause lesions (bone tumours, anaemia, etc.) leading to death.

Armageddon or Fontenoy? *

Total nuclear war or limited conventional war?

By General L. M. Chassin, Paris

Born at Bordeaux in 1902, General of the Air Force Chassin entered the Ecole Navale at the age of 17. In 1926 he transferred to the Naval Air Service, and in 1935 was posted to the French Air Ministry. He was appointed to the Air Staff in 1939, and during the war commanded a medium bomber wing. Promoted to the rank of General in 1946, he subsequently held a number of high appointments, including command of the Air Force Schools and command of the French Air Force in Indo-China from 1951 to 1953. A member of the *Conseil Supérieur de l'Air* and the *Conseil Supérieur des Forces Armées*, founder of the review "Forces Aériennes Françaises", General Chassin has published a number of books on military theory, which have been translated into several other languages. At present he is attached to SHAPE, where he is responsible for coordinating air defence at Central Europe headquarters. He has been awarded six decorations and has 5,700 flying hours to his credit.

It would be vain to deny it. The peoples of the whole civilized world are haunted by the spectre of total nuclear war. For the first time in history, mankind holds within its hands the ability to destroy itself utterly. Unlike earlier advances in weapons which were made in slow stages, the advent of the atomic age has introduced a sudden, total change, as the new explosive is incomparably more murderous in its effects than any hitherto known. Blast, heat, radiation and fall-out represent so great a threat that mankind has taken fright, like the sorcerer's apprentice unable to control the terrifying forces he has conjured up. Man realizes obscurely that, unless something positive is done, the fateful march of technical military progress threatens universal destruction. This is why not only scientists but also politicians in all countries are demanding a halt on the road to death. "The atom condemns us to peace", is heard on all sides. Yet there are few men who believe in their heart of hearts that it will be possible to abolish all forms of war. As long as men are men, with their passions and ambitions, conflicts will arise which can be solved only by recourse to force. The practical problem confronting our generation today is therefore the following: Is it possible to fight a war which will not automatically lead to total disaster? Is such a war likely? Must we prepare for it now?

Atomic war is certain suicide

We entered the atomic age in 1945 and have already passed through three stages.

The first was characterized by the "atomic monopoly" which gave the West complete military superiority over its adversary. Even had the latter thrown in all its vast conventional armies, it could not have hoped to emerge victorious from any major conflict, since—despite all that Stalin and the Communist theorists said at the time—the West was capable of inflicting mortal wounds. The result of this total nuclear superiority was two-fold. Firstly, it fostered among the Western nations an attitude of unchallengeable scientific and technological superiority which was considered as due to the system of political freedom and free competition under which we live. This attitude led to a belief that we could afford to weaken our conventional forces since we held the decisive argument (the bomb and the means of delivering it).

Yet during this period, which lasted nearly five years, it was the East rather than the West which scored the advances on the political checkerboard: satellization of Poland, Rumania, Bulgaria and, finally, the Prague *coup d'état*. Even at this stage it was already felt that the "big stick" was not altogether easy to manipulate, or at any rate lacked flexibility.

The second phase began in 1949, with the detonation of the first Russian atom bomb. Though thrown slightly off balance, the West at this time rapidly regained its optimism, based firstly on superiority in the matter of strategic air power and secondly on the belief that, with our "obvious" scientific superiority, we should always remain in the lead in the nuclear field. What if the Russians did have the A-bomb? We would be the first to make the H-bomb, and so on! This period was then marked by the formation of N.A.T.O. and the check provided by the Korean war.

We have just recently entered the third phase, in which we have been obliged to recognize that the results obtained by the U.S.S.R. in the field of intercontinental missiles and satellites have brought about a situation of nuclear parity. The most serious consequence of this realization is that, in future, a total nuclear war can end only in mutual suicide, which would doubtless mean the end of our civilization. It is obvious that, once the "Biggest Two" possess a sufficient number of I.C.B.M.'s, properly camouflaged and dispersed among hundreds of launching sites, it will be absolutely impossible for an aggressor to destroy them all, even by a surprise attack. The surprise factor which might perhaps have played some part in the age of strategic aircraft, if the detection system had failed, will no longer count in the new situation. Even after suffering a devastating atomic attack which has destroyed its basic structure, the nation attacked will always be able, before breathing its last, to launch its ballistic armada of death-dealing reprisal weapons.

Hence, at any rate until new scientific discoveries produce some effective means of defence against missiles, the "nuclear stalemate" will persist. No defence will be possible, and the Big Two will really resemble two scorpions at the bottom of a jar. Even if one stings first the other will have time to sting back before dying.

Is limited nuclear war possible?

As total nuclear war appears to be out of the question in the future, the strategists are falling back on the concept of limited nuclear war. This type of conflict would favour the West, since it reduces the importance of numbers. Unfortunately, it seems hardly likely that it would be possible to agree, tacitly or otherwise, on a limitation in the use of atomic weapons. A limited atomic conflict would run the grave risk of degenerating rapidly into total war, with each side gradually increasing the weight of its bombs and their radius of action, and after every set-back seeking to regain superiority by selecting a more powerful weapon from its arsenal. The transition is too easy, and any violation of agreements too simple to camouflage or to argue over: each side can so easily accuse the other of breach of faith, without there being any possible means of deciding who is in the

* *Armageddon* – scene of the supreme conflict between the nations. Revelation XVI, verse 16. *Fontenoy* – 1745, the War of the Austrian Succession; the English and French commanders each invited the other to take the first shot.

right. Admittedly, it might be possible to ban the use of I.C.B.M.'s. But could the same be applied to the I.R.B.M.? And if, one day, an important target is selected at a distance of 2,000 miles, who shall say whether the weapon used to attack it falls within the authorized or the unauthorized category?

Moreover, an important point which must not be overlooked is the deep horror with which men today regard all atomic weapons, whether they be tactical or strategic. The major European cities could quite well be totally destroyed by tactical atomic weapons. The distinction between civil and military targets died during the last war, when it was realized that a skilled worker was just as important to the war effort as a tank driver or a machine gunner.

Limited nuclear war is therefore highly improbable.

Woodcut by Albrecht Dürer to illustrate the opening of the sixth seal, Revelation VI/12-17: ". . . and, lo, there was a great earthquake; and the sun became black as sackcloth of hair, and the moon became as blood; and the stars of heaven fell unto the earth . . ."

Conventional war

Yet everyone feels that there will still be wars. If mankind is to survive, these wars must be waged solely with conventional weapons, without even the smallest use of nuclear weapons or, we should add, chemical or bacteriological weapons. World War II proved that, by tacit agreement, such dangerous weapons as chemical gases could remain unused. Large bombs carrying phosgene, mustard gas and more terrifying chemicals were manufactured by all countries, but they remained in the stockpiles and were not taken out even at the last moment by the side facing immediate defeat.

Why should it not be the same with nuclear weapons?

Obviously they must be kept in reserve as a deterrent and for reprisals in the event that the enemy, in an access of madness, should suddenly decide on this crime against humanity. As the question of legitimate defence then arises, the West would be perfectly within its rights and indeed under the obligation to counter-attack with the same weapons. Launching sites will therefore be prepared, dispersed, protected and camouflaged, and missiles stocked in the vicinity. But as soon as the total availability is sufficient to inflict decisive losses on the enemy, it will be pointless to go on producing more. What would be the use, in a sub-machine gun duel at thirty yards range, in having more than twenty bullets in the magazine? It is not necessary to kill a man twice. On the other hand, scientific research in the defence field must be continued, although it may well one day supersede atomic weapons themselves and open up interplanetary battlefields. Moreover, military scientific research has been responsible for many of the great peaceful industrial discoveries which have shaped the world of today.

Conventional war has the "advantage" of being strictly limited. Nuclear weapons are so far removed from all others that it is easy to determine whether or not they are used. Any violation of the law would be clear-cut and would leave no room for discussion—at any rate sincere discussion. World opinion would be immediately informed, and the guilty party would find all the neutrals ranged against it.

Whatever may be said, there is a difference of degree between a conventional war, even if total like the 1939—45 war, and a nuclear war. However cruel it may be, a conventional war will never destroy mankind. The last world war did not even visibly brake the increase in world population, and industrial production throughout the world soon exceeded that of the best pre-war years. Problem No. 1 of today's world has become rather one of overcrowding than of reconstruction.

The Western countries, however, find the idea of conventional war difficult to accept because, just as they were for a long time convinced that they would emerge victorious from a nuclear war, they equally firmly believe that the Russians would inevitably win a conventional war.

"Better a suicidal nuclear war", say some people, "than defeat in a conventional war."

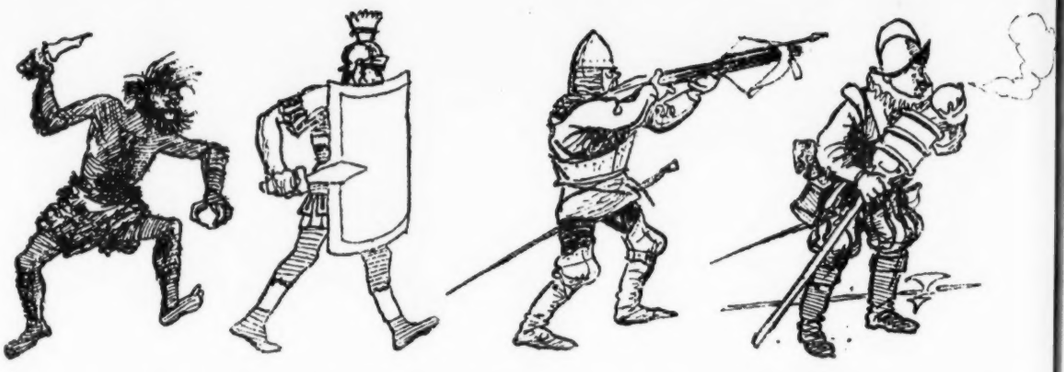
These people have very quickly forgotten that in the last war Russia, when attacked solely by Germany, found itself within an ace of disaster. True, it is undeniable that conventional warfare demands a high degree of personal courage, endurance, sacrifice and suffer-

When wars were gentlemanly: "Messieurs les Anglais, fire first" (from Pierre Daninos: Major Thompson Lives in France. French original: "Les carnets du major Thompson", Librairie Hachette).

Multi-purpose armament?

Progress in the art of war... from dagger to dagger

(By courtesy of "Punch" and "Forces Aériennes Françaises")



ing on the part of the combatants, and its preparation in peacetime throws a heavy and unwelcome burden on whole peoples. When the West adopted the concept of "scientific" war, was it not hoping to be able to replace the vast armies of the past by small squads of scientists, to close down the barracks and abolish compulsory military service, in a word to relieve modern man of the physical and moral hardships which he tolerates with increasing impatience? Unfortunately, it is today clear to what impasse this road has led us.

This is a situation which we must face squarely. With their population and their wealth the Western countries can well afford to build up sufficient *conventional* land, sea and air forces to fight the battles likely to occur in the future. And these forces will not need to be as vast as might appear at first sight, as the wars of the future will most probably be limited wars.

Return to limited wars

For many centuries, during European civilization's most brilliant period, the wars waged by princes and kings remained limited wars, which never jeopardized the actual existence of the countries concerned. Being based on sound political principles, which did not automatically seek the total destruction of the enemy, and waged with small-scale armies and according to clearly defined rules, they enabled war to be humanized as far as this is possible. Total wars, with all the implied devastation and ruthlessness, are "ideological" wars, in which fanatical combatants seek to convert the whole world to their faith. But when "faith" cools, the likelihood of total wars is also reduced. Thus if the idea of peaceful coexistence should be preached on the other side of the Iron Curtain, we should be justified in hoping that the apostolic virulence which has aroused the Communist masses for several decades past will give place to more reasonable considerations, and that it will be possible to return to a form of war that is less dangerous for everybody. Moreover, it should not be forgotten that the side wishing to keep to a limited conventional war can call upon a massive argument: the threat to go over to total nuclear warfare in the event of any extension of the conflict. The choice confronting belligerents in the years to come will thus be either to wage limited wars without using nuclear explosives or to go to the furthest extreme and risk mutual suicide.

We must also not overlook the fact that—as we well know—the Communists can engage in yet another kind of conflict: namely war by means of internal subversion, characterized by a *coup d'état* or a revolution engineered by a determined minority, as in Prague in 1948. But these are purely internal affairs, strictly civil wars, which can be avoided by appropriate political measures and hence do not fall within our present subject matter.

Let us make no mistake. In most cases wars have taken very different forms from those forecast by even the most revered of prophets. The 1914—18 war was to have been a short and brutal war of movement: it became a long and uninspired trench war. The war of 1939 was prepared in a defensive spirit, characterized by the Maginot Line. In reality it was a war of movement and of large-scale offensive manœuvres. It was expected to see the massive employment of chemical weapons. It did not see them, probably for precisely the same reasons as will forbid nuclear warfare tomorrow. The use of poison gas could have made the air forces into the "absolute weapon", through the extent of damage caused to the enemy. But this weapon was not used.

In more recent days, during the Korean War, the two belligerents tacitly fixed limits beyond which they would not go. The Americans respected Chinese territory, and the Communists avoided attacking the ports of Fusan and Inchon, and above all refrained from using submarines either in the Sea of Japan or the China Sea. Both knew that any success they might have obtained in such operations would have led to an extension of the conflict in the direction of a general conflagration which both wished to avoid at all costs.

It is therefore not correct to say that man would automatically go to the extreme limits of his military capabilities, or that once a war started it would be impossible to say where it would end.

As a rule, war breaks out for a very definite reason. In olden times the heads of States were able to call a halt as soon as they considered that the "game was no longer worth the candle;" that is to say, when the losses sustained in the war exceeded the advantages to be gained from eventual success. The Crimean War is an excellent example of this type of conflict. Obviously, the Franco-British capture of Sebastopol was in no sense a decisive victory capable of forcing the mighty Russian empire to seek peace. Yet the Czarist Government did ask for peace; because it considered that its aims, namely freedom of the Black Sea and of the Straits, were not worth the heavy losses inflicted on the country by the war. The result was a moderate peace, easily borne by both sides, and which did not sow the seeds of a later war.

The last war, on the contrary, though officially started over the Danzig question, gradually developed into a vast scrimmage in which the original cause was forgotten, and ended in incredible confusion, in a highly precarious state of "peace" where the allies of yesterday are today in opposing camps and the enemies of yesterday are in the same camp! Total war, war considered as a duel to the death, terminating in "unconditional surrender", has so clearly revealed its stupidity and its destructiveness that mankind may perhaps at last understand the danger in which it stands.

Hence it would be wiser to plan armies capable of waging limited conventional war, and not rush headlong along the road to total nuclear war. If we do not grasp this fact, the U.S.S.R. is likely to find itself, a very few years from now, in a much better situation

than we are. It will be able to fight any kind of war, subversive, conventional or nuclear, while the West will merely be able to brandish the "big stick"—a cumbersome weapon which is more dangerous than useful.

What must we build for the future?

Any doctrine of warfare is essentially a gamble on the form which a future conflict will take. And the ultimate, practical consequence of a doctrine is to know on the one hand how to organize the armed forces, and on the other what equipment to give them. At the present time, most military planners act as though all future conflicts will necessarily be atomic. We must resist this trend if we do not wish to run the risk of having to choose between defeat and suicide. Hence we must be equipped to cope with limited conventional wars.

In the matter of ground warfare, this kind of conflict naturally involves considerations which the Western nations, not being anxious to sacrifice their quiet, comfortable lives, find unpalatable. Yet the answer is clear: we must continue to mobilize men, form infantry divisions, train soldiers to march on foot and defend their lives under dangerous and unpleasant conditions. In a word, as all the N.A.T.O. chiefs have been rightly demanding for years, we must create an effective shield in the dangerous area of friction. If, for example, the Bulgarians should decide tomorrow to venture on a masked attack on Greece in the direction of the Aegean Sea, N.A.T.O. must be immediately capable of localizing and limiting the conflict, by intervening as the United Nations did in Korea. The same danger may arise in Germany, in the Middle East, or perhaps even in Africa. From the air force point of view, this doubtless would mean creating a standing strategic force capable of being transported immediately by air to the threatened point, so as to prevent a brush fire from spreading into a full-scale conflagration. But it is above all in the field of air armaments that we must change our ideas completely. There is no denying the fact that, today, "missilitis" has taken hold of many thinkers. The eclipse of the piloted combat aircraft is regarded as a certainty and its demise is foretold week after week by many of the best brains.

But most of the missions to be performed in conventional war require very different equipment from that used in nuclear war. The latter is the realm of the missile, and a missile is often not worth building unless it has a nuclear warhead. Despite the extraordinary scientific and technical advance it represented, the V2 was ultimately a failure for Hitler, because each delivered only one ton of T.N.T. on England. If it had had a plutonium warhead, the outcome of the war would probably have been changed.

Missiles must be divided into two classes: those that are "worth-while" without nuclear explosive, and the others. The first category includes air-to-air missiles and, under certain conditions, surface-to-air missiles. The second covers all the surface-to-surface missiles. When it comes to air-to-surface missiles, a closer study of the question is needed*. This factor of "worthwhileness" decides the structure of the air forces for tomorrow's limited wars.

If we consider the missions to be fulfilled, we see immediately that all offensive missions will continue to be performed by piloted aircraft. Piloted bombers may be armed with glide or guided bombs, if the load of conventional explosive carried is sufficient to produce adequate results on certain military targets. But it is obvious that long-range non-nuclear guided missiles cannot be used in the place of piloted bombers.

For support missions there is equally little doubt. The human brain is so far superior to that of any missile that none of this work can be entrusted to the latter in a conventional war. (Even in nuclear war the superiority of the robot weapon is far from being firmly established).

* Incidentally, it is difficult to imagine air-to-air or air-to-surface missiles being launched from anything but conventional aircraft.

As for defensive missions, the choice will be between the piloted fighter armed with air-to-air missiles and the surface-to-air missile. For short-range defence, the missile will probably be chosen, as replacement for the old anti-aircraft guns. For the wider mission of defence against raiders, the fighter, being manœuvrable and capable of recovery, will most probably continue to be an unequalled instrument. Paradoxically, however, certain reconnaissance missions and perhaps, some day, transport missions may be accomplished by robots, if their cost can be reduced sufficiently.

From the point of view of strategy, the most important point to be noted is that conventional war without nuclear weapons brings us back to the "sustained offensives" and "battles of attrition" for aerial supremacy. Without atomic bombs, bombers will be unable to obtain decisive results within a short time. Defence against attack will again become long and tough but, as in the past, will be decisive. Air defence, today considered to be unnecessary and costly, will once again become of capital importance.

In our view, then, we must continue to build piloted aircraft. Needless to say, the struggle for technical superiority will be pursued as keenly as ever. But it is permissible to hope that, if we make the necessary effort, we shall not be outclassed by the adversary in a domain which is familiar to us.

In any case, serious consideration must be given to the probability of limited conventional wars, the only alternative form of war to the final holocaust. As in the past, conventional war can be "humanized" and can lighten the increasingly heavy burden which defence lays upon all the nations. If we cannot hope to eliminate war altogether, human nature being what it is, we must seek to reduce its destructiveness. Who would have thought that one day the appearance in the sky of bombers carrying conventional explosives could raise not cries of terror, but a sigh of relief?

Multi-purpose armament?

The Soviet Union's New Tactical Bombers and Fighters

At the Tushino parade in June 1956 the Soviet Air Force demonstrated a number of new types of aircraft which are now in large scale production and, to some extent at least, in operational service. The following short report is concerned with four of these types, all designed for service with the Tactical Air Force and illustrating the efforts being made by the Soviet Union to build up a multi-purpose striking force with a limited radius of action.

Most important are two new supersonic bombers which have attracted considerable attention from military observers: 1—a swept-wing design from the Ilyushin stable, which N.A.T.O. has designated *Blowlamp,* for the ground support and attack role, powered by two jet turbines mounted in below-wing pods; 2—the N.A.T.O. designated *Backfin,* possibly also developed by Ilyushin, a swept-wing design with twin jet turbines mounted in the rear fuselage, but whose precise role is not yet clear.

The *Blowlamp* is clearly intended as a successor to the Ilyushin Il-28, and has been developed specifically for high performance at very low altitudes. The bomber was first seen, on the ground at Kubinka airfield, at the time of the 1956 Moscow Air Parade, and in the meantime has entered operational service in limited numbers. The powerplant comprises two jet turbines with short integral afterburners, each of 11,000 lb. static thrust (without afterburner); according to Russian sources these engines have been designated MR-40. A decisive factor in the multi-purpose employment of the *Blowlamp* is its very short take-off distance, which American sources give as 3,000 ft. using the afterburners. Outstanding characteristics are: transparent nose section for the navigator/bombardier; twin tandem undercarriage retractable into the fuselage belly, with supporting wheels at the wing tips; sharply sweptback wing (mean sweep 45°) with a total of four boundary layer fences; air brakes on the fuselage sides; ventral fin at rear of fuselage; remote controlled or radar directed rear gun turret.

The second of the supersonic bombers, the *Backfin,* has unusual configuration and powerplant installation; the twin jet turbines are mounted side by side in the rear of the fuselage, and are fed by long air intake channels with the actual air intakes located at the side of the fuselage, forward of the extremely thin main wing. This installation permits an unbroken wing with large flap areas, but due to the length of the air intake channels probably does not permit full use to be made of the available fuselage space. Apart from these features the *Backfin* has a low-set slab tailplane, retractable tricycle undercarriage, and a small fairing at the base of the fin and rudder unit, possibly for a brake parachute or rear-view radar. In weight, performance and possible role the *Backfin* is perhaps comparable to the Avro CF-105 supersonic heavy fighter. The bomber is reported to be in production, but it is doubtful whether it is yet in squadron service.

The MiG-21 *(Faceplate)* supersonic fighter is quite clearly a development of the MiG-19 *(Farmer).* It has a single power unit, with afterburner; the jet air intake in the fuselage nose has a conical central body; the tailplane is all-flying. Compared with the MiG-19 the pilot has improved visibility obliquely downwards. A few aircraft of this type, possibly prototypes, show a different wing design in which the trailing edge is straight for about 25 percent of the span. Other characteristics of this aircraft, now in operational service with the Soviet Air Force, are: three cannon blisters at the front of the fuselage belly; air brakes below the rear fuselage; two ventral fins below the rear fuselage. In its performance the MiG-21 is roughly comparable to the United States' "century series" of interceptors; however the radar and fire control systems do not appear to come up to Western standards.

The Soviet Union's most outstanding interceptor is the Sukhoi-designed delta aircraft, which N.A.T.O. has christened *Fishpot.* This aircraft was shown in prototype form at the 1956 Moscow Parade; since that time it has frequently been observed in small formations, and is now believed to be in operational service. Equipped with what is apparently the most powerful Russian jet turbine unit available today, *Fishpot* is probably capable of speeds in excess of Mach 2, with an impressive climb performance. The tailplane has separate elevators, and the delta wing has conventional ailerons. Comparable in weight and air intake configuration to the Chance Vought *Crusader, Fishpot* appears to be the champion in the Soviet fighter stable, especially as the nose design suggests that long-range precision target radar is installed.

Ilyushin (Blowlamp)
2 jet turbines each of 11,000 lb. thrust, without reheat or 15,000 lb. thrust, with reheat.

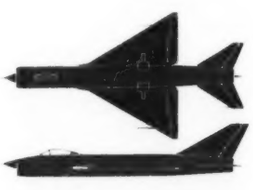
Span	= 65.6 ft.	Max. speed at 36,000 ft.	= Mach 0.98 (without reheat)
Length	= 75.5 ft.		= Mach 1.3 (with reheat)
Take-off weight (normal)	= 25 tons	Range at full power	= 850 n.m.
Take-off weight (maximum)	= 27 tons	Range at economical rating	= 1,350 n.m.
		Ceiling	= 52,500 ft. (with reheat)

Ilyushin ? (Backfin)
2 jet turbines each of 15,000 lb. thrust, without reheat or 21,000 lb. thrust, with reheat.

Span	= 35.2 ft.	Max. speed at 36,000 ft.	= Mach 1.5
Length	= 57.2 ft.	Range (normal)	= 1,350 n.m.
Take-off weight (normal)	= 32 tons	Range (max.)	= 1,600 n.m.
Take-off weight (maximum)	= 35 tons	Ceiling	= 59,000 ft.

MiG-21 (Faceplate)
1 jet turbine of 20,000 lb. thrust, with reheat.

Span	= 32.8 ft.	Max. speed at 36,000 ft.	
Length	= 49.8 ft.		= Mach 2
Take-off weight	= 10.4 tons	Ceiling	= 62,000 ft.



Sukhoi (Fishpot)
1 jet turbine of 20,000 lb. thrust, with reheat.

Span	= 24.9 ft.	Max. speed at 36,000 ft.	
Length	= 50.1 ft.		= Mach 2
Take-off weight	= 9 tons	Ceiling	= ? ?

From a painting by Roy Cross

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NATO's Lightweight Strike Aircraft

A "Combatworthy" Weapons System Founded upon the Classic Principles of War

By Colonel John J. Driscoll, USAF Weapons Systems Project Officer, Programs Division, SHAPE

Just prior to World War II, John J. Driscoll was employed in the U.S.A. as a Research Metallurgist and Tool Designer. During 1942–45, he served with the U.S. Eighth Air Force as a Combat Operations Officer in Europe and North Africa. Following post-war studies in Germany and Japan as Chief, Air Weapons and Tactics, U.S. Strategic Bombing Survey, he was appointed to the faculty of the U.S. Air War College, 1947–49. Subsequently he served with the Directorate of Operational Requirements, and the Directorate of Research and Development, in the U.S.A.F. Headquarters. After a combat tour in Korea, he was assigned as Advisor to the Commanding General, French Far East Air Forces, Indo-China. His pioneering N.A.T.O. assignments include service as the first Military Member of A.G.A.R.D., and later as the first Chief of the Air Section, U.S. Mutual Weapons Development Team. Following his recent duty as Operations Analyst with the Weapons Systems Evaluation Group, Office of the U.S. Secretary of Defense, he received his present assignment as Weapons Systems Project Officer on the S.H.A.P.E. staff.

Since World War II, it has become increasingly evident that the 1939 concept of the "all-purpose" fighter is no longer valid. In the nineteen thirties the average "pursuit" aircraft had a speed of interception that happily coincided with the optimum fighter-bomber speed range. With the advent of supersonic bomber targets, however, the interceptor now became specialized due to the great speed differential between the two roles, a difference in optimum speed requirements of the order of a thousand miles an hour. The interceptor's essential air-to-air missile and its attendant complex fire-control system tended to make the weapon systems even more specialized. The different air densities found in the ever-diverging operational altitudes of these now distinct roles further increased the disparity between the two systems; there was an increasing differential in load factor requirements.

Even within the specialized fighter-bomber role we find a further division caused by two distinct operational missions, particularly in N.A.T.O. Europe, which have resulted in a divergence in the required characteristics of strike fighters. The U.S.A.F. F-84 type aircraft has an important mission in operating at fairly long tactical ranges from fixed bases generally situated well within friendly territory. In Europe, however, there is also a need for a more highly mobile striking force operating in closer liaison with the N.A.T.O. ground armies. These specialized conditions dictate the requirement for a simpler, more easily maintained tactical strike aircraft, to complement the conventional long-range fighter-bomber role. These aircraft should be divorced from the conventional fixed base and concrete runway, and must be capable of operations from unprepared terrain. Unlike the conventional fighter-bomber system, these aircraft would be widely dispersed on the ground and hence not offer an easily-pinpointed target.

Unfortunately, currently available and programmed fighter-bomber aircraft were unable to fill the N.A.T.O. needs due to a generally increasing trend toward greater complexity. The broader technical objectives and longer ranges involved, particularly in U.S.A.F. operational requirements, tend to increase the aircraft weight and complexity, which in turn results in increased maintenance difficulties. Even the lightest weight U.S.A.F. tactical aircraft are unfortunately anchored to fixed-base systems which are overly complex and too expensive for this special European role. Such fixed installations, incorporating one to two mile concrete runways, characteristic of the more costly conventional weapon systems, also involve a base structure too vulnerable for the operations envisaged by S.H.A.P.E.

A survey of N.A.T.O. aircraft inventories failed to reveal any design which fulfilled the need for N.A.T.O.'s required mobile air striking force. S.H.A.P.E., therefore, established a specific requirement for a simple but robust ground attack aircraft tailored to the needs of the European situation—the N.A.T.O. Lightweight Tactical Strike Fighter.

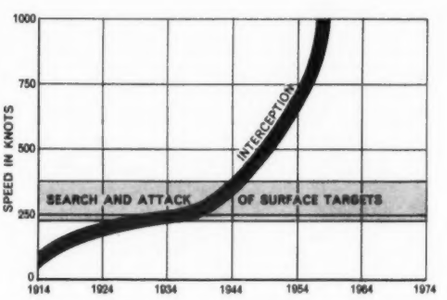

Diagram 1: Evolution of speeds of interceptors (curve) and strike aircraft (shaded band) from 1914 to 1974.

Bomber speeds have increased from some 70 knots in World War I to Mach 2 and beyond, and interceptor speeds have increased accordingly. During the same period, the speeds of mobile ground targets have remained more or less unchanged. The mobile, but clumsy, guided missile of today may have cross-country speeds at least as low as that of the old horse cavalry.

In World War II fighters and attack aircraft had much the same speeds, which led to the multi-purpose fighter (interceptor, escort, fighter-bomber) such as the North American P-51 *Mustang*. Today the increasingly divergent characteristics of the interceptor and the tactical attack aircraft, in speed, wing loading and armament, emphasize the need for specialization.

The optimum speed range for search and attack of surface targets must obviously include a higher top "escape" speed, to enable the strike aircraft to evade interceptors and ground defences.

Founded upon basic studies undertaken at Allied Air Forces, Central Europe (Fontainebleau), a S.H.A.P.E. requirement evolved for N.A.T.O.'s first "internationally-conceived" Air

The comparative tests of N.A.T.O. strike fighter prototypes at Brétigny (September 1957): left to right: Sud-Aviation SE.5003 *Baroudeur*, Fiat G.91, Breguet 1001 *Taon* and Dassault *Etendard IV*. – Rear right, a Fouga *Magister* and a number of Gloster *Meteors*.

The Classic Principles of War	N.A.T.O. Tactical Strike Aircraft	Conventional Tactical Strike Aircraft
The principle of the objective: The purpose of a military operation is the attainment of the *objective* assigned a designated force. Each weapon system has its objective. The L.W.S.F. weapon system supports the attainment of the primary objective of the ground forces; shielding the West against infiltration or invasion. By definition a shield must be relatively invulnerable and maintained forward of its more vulnerable complementary weapon systems.	Having the capability of operating and surviving in front-line areas, the L.W.S.F. furnishes direct and immediate augmentation of the objective of the Shield in preventing penetrations of the critical forward areas.	Generally anchored to relatively vulnerable bases located in areas too far rearward to permit direct contact with the ground forces.
The principle of the offensive: The shield alone can only avoid defeat; therefore, it is coupled with the sword—the *offensive* capability—which is essential to the attainment of a decision.	Maximum sorties per unit of time due to extremely rapid "turn-around" (re-arming and refueling) capability, and to the proximity to both the intelligence sources and the targets. Carries full (maximum) load of any selected weapon type due to special concept engineered into armament system.	All conventional tactical strike aircraft to date have a "turn-around" time averaging ten times or more ground-handling time than the N.A.T.O. L.W.S.F. Distance from intelligence sources and targets correspondingly increases delay of follow-up strikes. Integral guns normally preclude optimum (maximum) bomb load.
The principle of mass: *Mass* means combat power. Numerical concentration of essential weapons affords the basic means of increasing this combat power. Success in war is attained by the capability of employing Mass in a coordinated effort in the time and place essential to accomplishment of a specific objective.	Practically no limits, due to high capacities of natural geographic areas; and most unprepared areas are suitable without any requirements for hard runways.	Tied to capacities and facilities of existing airdromes; including limitations imposed by areas of hardstands and length of runways.
The principle of economy of force: Combat power resources—men and materiel—are not inexhaustible, and the principle of *economy of force* must be applied to all efforts. Effective combat power may easily be precluded by disregard of the economic aspects. Overly-complex weapon systems may mean fewer total weapons and frequently lead to uneconomical employment of manpower in maintenance.	L.W.S.F. Squadron is designed toward minimum support from ground crewmen employing only a few pieces of mobile support equipment. Low unit cost per aircraft.	Conventional squadron requires support of high percentage of ground crewmen including numerous complex fixed installations. Aircraft cost approximately three times that of L.W.S.F.
The principle of movement: *Movement* relates to the potential mobility of the combat elements. In the offensive, this principle is used to rapidly assemble the Mass necessary to secure decisive results or to permit its deployment so as to permit an attack with advantage. In the defensive, the principle is used to avoid or parry a hostile strike, or to place mass where it can counter-attack with advantage. Movement is most effective when concealed.	Complete mobility of weapon system components permits rapid deployment in central Europe; plus capability of rapid redeployment to any peripheral area.	Capability for rapid deployment in central or peripheral areas governed by geographic locations of existing bases.
The principle of surprise: *Surprise* in some form is essential in order to obtain the maximum effect with the minimum loss. It may take the form of time, place, direction, force, tactics, or weapons. Secrecy, rapidity, and preparation are the main factors.	Secrecy and rapid employment are easily secured advantages due to the designed capability of the L.W.S.F. for concealment through mobility and dispersion.	Conventional air bases are generally well-publicized in peacetime and consequently have a high degree of vulnerability.
The principle of security: Security embraces all measures taken to guard against observation and surprise, to insure against effective hostile interference with operations, and to gain and maintain the power of free action.	Easily secured against observation by dispersal in woods, barns, etc.	Anchored to the existing publicized pattern of vulnerable permanent air bases.
The principle of simplicity: *Simplicity* is a relative term which relates to plans, orders, command, tactics, and the weapons themselves.	A simple and self-sufficient air weapon system free from the usual complexities.	An increasingly complex air weapon system dependent upon a complex air base structure.
The principle of cooperation: By *cooperation* is meant the working together towards the accomplishment of a common mission, in short, "teamwork".	L.W.S.F. system permits intimate joint air-ground operations from the Army front-line area in direct support of the ground forces.	Extent of actual direct support tending to decrease with the increasing complexity of the rear-area operational bases, and increasing communications problems due to remoteness from Army area.

The Brétigny test pilots: French, Italians and Americans (judging by their badges, members of the Air Research and Development Command).

Weapon System. The establishment of an Advisory Committee on the N.A.T.O. L.W.S.F., sponsored by Dr. Theodore von Kármán, Chairman of A.G.A.R.D., working in close coordination with the military planners, has insured the development of a truly combatworthy aircraft. Although designed to destroy such elusive and dangerous surface targets as mobile missile units, this weapon system, despite its modernity, is founded upon the classic and ageless "*Principles of War*".

From the study of military history, there have been deduced and enumerated what are universally accepted as the "Principles of War". Historical evidence, including the early Roman battles, shows that the great commanders have always been guided by them and that success or failure in military operations has always been dependent upon the extent and manner of their application. In the United States these principles are generally expressed as follows:

1. The Principle of the Objective.
2. The Principle of the Offensive.
3. The Principle of Mass.
4. The Principle of Economy of Force.
5. The Principle of Movement.
6. The Principle of Surprise.
7. The Principle of Security.
8. The Principle of Simplicity.
9. The Principle of Cooperation.

These principles are basic and have been unaffected by technological advances. They are as valid in this atomic-missile age as they were in the era of the Roman legions. The degree and scope of application of the various principles is, of course, dependent upon the situation; and there will obviously be a number of potentially effective courses of action for each tactical problem. Generally speaking, however, the application of these principles normally begins on the battlefield. Any operational analysis will show, however, that the potentials afforded a military commander by each principle are generally *limited* by the technology of the weapons in hand. It was clear to S.H.A.P.E. planners that the usual application of the principles of war to strategic plans and tactical operations was obviously not the optimum approach towards the solution. The supporting air weapon components of the Continental European Shield Forces would soon be unacceptably vulnerable in the face of the atomic missile threat looming over the

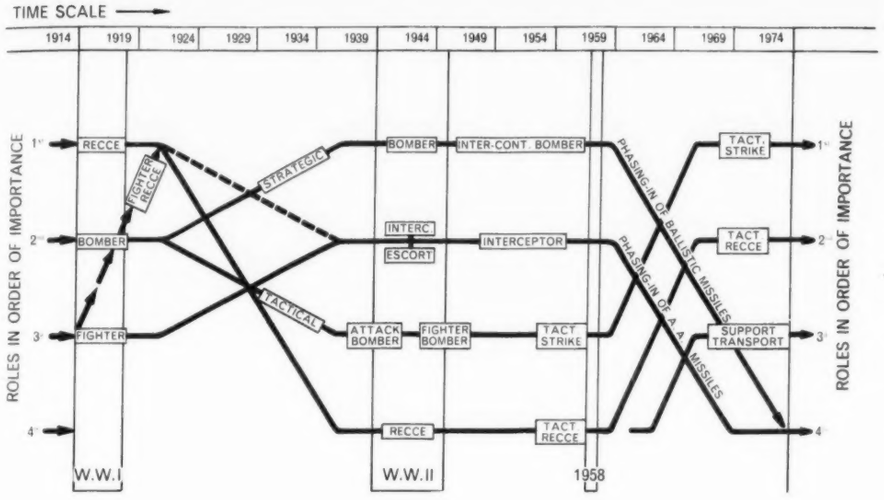

Diagram 2: The tactical strike aircraft becomes the dominant air weapons system among manned military aircraft.

At the outbreak of World War I the dominant manned aircraft was the reconnaissance biplane, which flew at 70 m.p.h. and could climb to 10,000 ft. The importance of early visual and photographic reconnaissance led to the transition into fighters and "fighting scouts" (fighter/recce). Improvised bombing was instituted early in the war, at first with grenades and modified artillery shells, and finally with specialized bombs as large as 1,000 lb. The support role, however, did not appear to any marked degree until 1916. Thereafter, interception and air fighting came to be concerned as much with the prevention and facilitation of support bombing operations as with aerial reconnaissance, and fighters developed into interceptors or escort fighters. The improvement of interceptor performance finally led to the emergence of specialized night bombers.

When long-range bombardment made it possible to attack the enemy's rear, the heavy bomber became the principal manned air weapons system, maintaining this position for some twenty years, while the interceptor assumed the secondary dominant role or served as escort to the bombers. There was then a split between strategic bombers and tactical bombers, with the latter taking the shape of attack bombers or fighter-bombers; the reconnaissance aircraft fell to fourth place.

Today we have reached another turning point: the interceptor has already begun to lose its status with the gradual phasing in of anti-aircraft missiles, and the intercontinental bomber will soon be deprived of its dominant role by the phasing in of ballistic missiles. With the availability of small, compact nuclear weapons and the advent of higher-energy fuels, the tactical strike fighter (or light attack bomber) assumes an increasingly dominant position, followed by the tactical reconnaissance aircraft and the support transport. All three, however, must be designed for short field and rough terrain operations.

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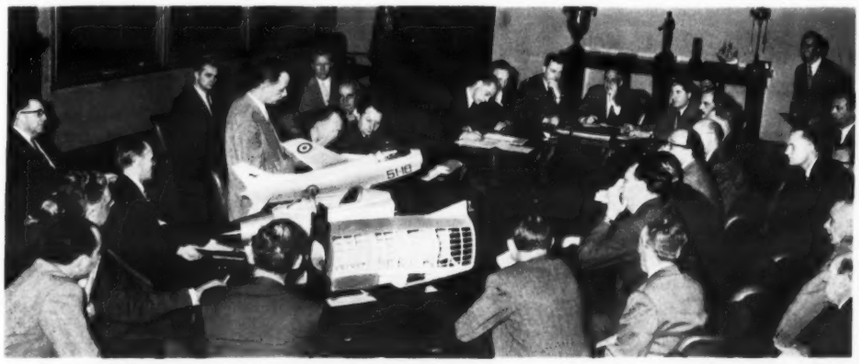
Commander E. Schuld (standing) presents the report on the light strike fighter flight tests to the assembled Committee members. To the right of Commander Schuld is Dr. von Kármán, at the far end of the table Dr. A.J. Marx, between Major A. Murray (in U.S.A.F. uniform) and Group Captain H. N. G. Wheeler (in civilian clothes).



horizon. The rapidly advancing technology of modern weapon systems was becoming the major differentiating factor evident in considering modern applications of the principles of war. Armament, *per se*, was a relatively minor factor in Clausewitz lifetime, when the flintlock rifle remained the standard dominant weapon. However, in this modern day of revolutionary weapon designs, the weapons themselves might easily prove the most serious handicap to the military planner. It was essential, therefore, that these principles of war be constantly borne in mind by the weapon system designer throughout the development phase. This basic philosophy—instituted as *Development Planning** in the U.S.A.F. in recent years—was the approach used by the L.W.S.F. Committee which had guided the N.A.T.O. military-scientific studies since 1954.

Since 1954, with considerable technical assistance from all the N.A.T.O. nations, and with financial support from the United States, United Kingdom, France, and Italy, N.A.T.O. has finally produced an air weapon system fully compatible with S.H.A.P.E.'s advanced operational concept. It is interesting to note how this end-product compares with the average *conventional* tactical aircraft in meeting the combat criteria expressed in the Classic Principles of War (see table).

Following the recent Bretigny Flight Trials, and supplemented by firing and vulnerability studies, Dr. von Kármán is expected to forward to the N.A.T.O. Standing Group his committee's recommendation naming a standard N.A.T.O. Lightweight Tactical Strike Fighter. This N.A.T.O. aircraft will be standard equipment for the squadrons scheduled for establishment under S.H.A.P.E. during the forthcoming three years.

N.A.T.O.'s development planning group continues to look ahead for the next ten years in order to insure the availability of the most combatworthy air weapon system for S.H.A.P.E.'s future tactical strike squadrons. Already the French Air Ministry has evolved a new advanced design study which promises to furnish an even more effective system for the next generation of lightweight strike aircraft. Under the guidance of S.H.A.P.E. and A.G.A.R.D., this L.W.S.F. weapon system, which may prove to have the most promising future career of all manned combat aircraft, continues to keep abreast of technological progress.

*

Future air weapon systems, manned and unmanned, must continue to exploit the principles of Movement through *mobility*, and Security and Surprise through *dispersal* and *concealment*. The technological trend at present is towards the perfection of S.T.O.L. and V.T.O.L. systems having a wide gamut of speed, from the hover to supersonic flight. Such future designs may assume the dominant roles after they achieve an acceptable compliance with the principles of Economy of Force and Simplicity.

* Pioneered by L. Eugene Root while attached to the Office of the Deputy Chief of Staff for Development, U.S.A.F. Mr. Root also established the first of many similar groups since set up within the U.S. aircraft industry. Root is now Director of Lockheed's Guided Missile Division.

Multi-purpose armament ?

A Weapon System in Practice

Support Equipment for the Lockheed F-104

When Lockheed Aircraft Corporation began the first preliminary studies for its F-104 light supersonic fighter in 1951, based on the experience of the Korean War, both the U. S. Air Force as customer and Lockheed as manufacturers agreed that the new aircraft must be designed from the outset as a complete weapon system and that all the ground support equipment required must be planned to ensure optimum utilization of the aircraft. Even before flight testing began in February 1954, Lockheed's Field Service and Training Division and Spare Parts Division had started work on an impressive range of ground support equipment, without which constant operational readiness could not be guaranteed for the F-104. And when, in February 1958, the Air Defense Command's first interceptor squadron was finally equipped with the F-104 *Starfighter*, it received at the same time a tailor-made "package" of ground aids, ranging from maintenance equipment to training aids, which could scarcely be more comprehensive. It is obvious that such detailed planning can have a decisive influence on an aircraft's export prospects.

The following examples illustrate the procedures for ground maintenance and handling of the F-104: the preflight inspection to be accomplished before the first flight of each day includes visual examination and operational tests to discover any defects or maladjustments and takes a 6-man ground crew an average of 57 minutes. The post flight inspection takes an average of 1 hour 38 minutes. Basically the latter covers routine checks on the functioning of equipment and the search for defects; post flight inspection will reveal early evidence of chafing, leaking or other minor conditions before these develop to the stage requiring major repair. In addition, complete periodic inspection of the aircraft is scheduled after every 50 flying hours, and takes an 8-man crew an average of 6 hours 54 minutes. With the squadron at alert status (i. e., aircraft in or near alert hangars, aircrew in ready room, starters connected, etc.), aircraft can get off the ground within 5 minutes of receiving scramble notification. Thanks to good accessibility and the carefully planned positioning of vital servicing equipment, the actual start, from closing of the canopy to taxying off, takes only 75 seconds, with the aid of a 3-man ground crew. *Diagram A* explains the role of the ground crew during an alert start.

Equally important in ensuring full utilization of the aircraft is rapid reservicing—maintenance checks, refuelling, rearming—between missions. An F-104 squadron can have its aircraft ready for a new take-off within 15 minutes after engine shut-off, regardless of weather conditions. If the 18 aircraft of an F-104 squadron return en masse from a mission (i. e., at minimum intervals of 30 seconds), the whole squadron will be in a state of operational readiness again in 24 minutes. *Diagram B* illustrates a complete turnaround reservice.

Some of the ground support equipment which enables the F-104 to be maintained and serviced within so short a time is described and illustrated on these pages.

Diagram A — Alert start of an F-104: The figures denote the tasks of the 3-man ground crew during the 75-second take-off preparations. During this time the pilot has closed the canopy, started up the engine and brought it up to idling condition.

Crew chief. 1. Remove right-hand duct cover. 2. Remove pitot cover. 3. Remove nose gear safety clamp. 4. Wave off.

No. 1 mechanic. 5. Start starter unit. 6. Remove tail pipe cover. 7. Detach start unit. 8. Cap starter connection. 9. Remove ground power. 10. Remove right-hand landing gear pin. 11. Remove right-hand chock.

No. 2 mechanic. 12. Remove left-hand duct cover. 13. Remove gun plug. 14. Standby fire extinguisher. 15. Remove left-hand landing gear pin. 16. Remove left-hand chock.

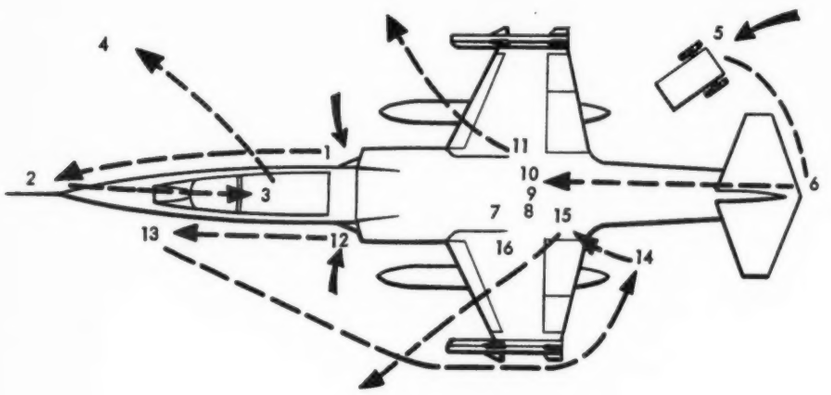
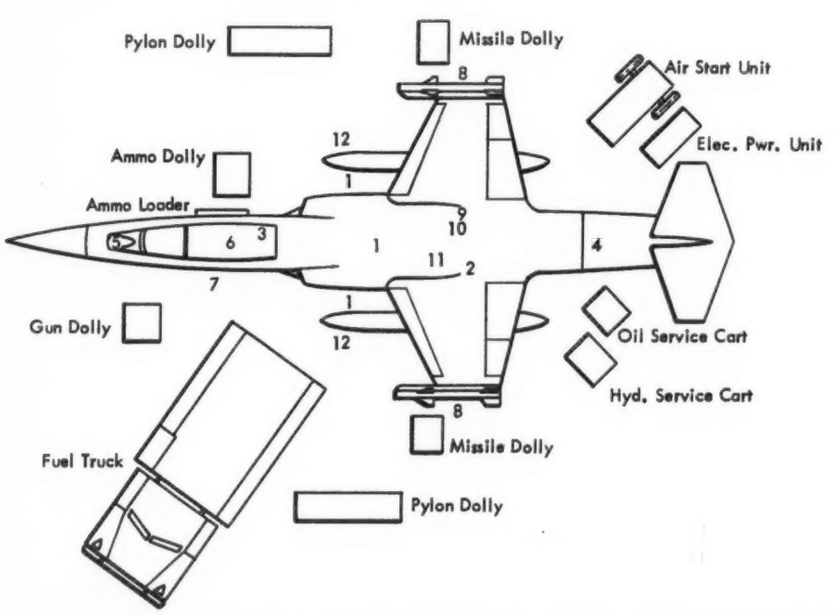
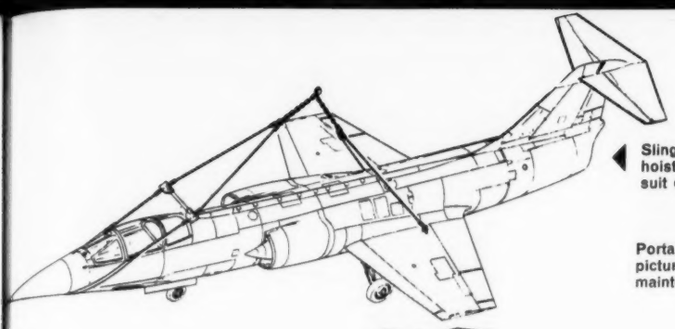
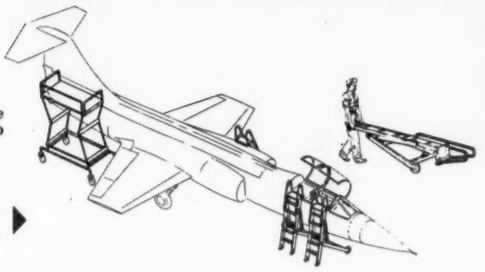


Diagram B — Reservicing the F-104 during turnaround: The diagram illustrates the ground equipment needed to accomplish a 13-minute turnaround between operations. During these 13 minutes the ground crew's duties are as follows: 1. refuelling; 2. replenish oil; 3. replenish oxygen; 4. replace drag chute; 5. reload camera; 6. reload ammunition; 7. replace gun; 8. install missiles; 9. electrical power connection; 10. air starter connection; 11. hydraulic replenishing; 12. install pylon tanks, if required.

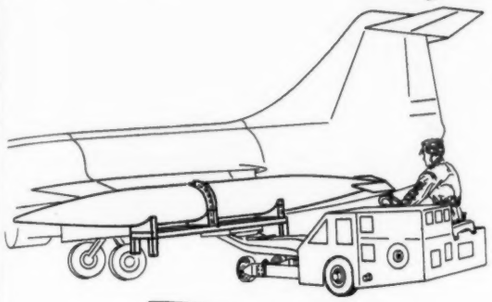




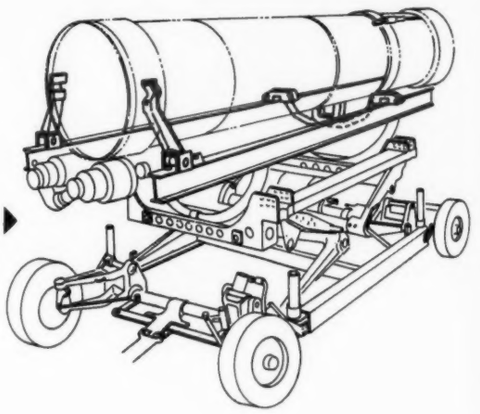
Sling for hoisting the complete F-104. The hoisting link can be moved along the chain to suit centre of gravity conditions.



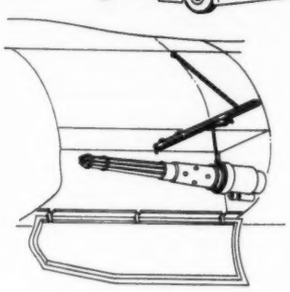
Portable folding utility ladders (on right in picture) and adjustable platforms facilitate maintenance.



Bomb dolly used in conjunction with an adapter for installing wing-tip tanks or assisting in the removal and installation of the wings. Tip tanks can also be stored in these racks after removal from the aircraft.

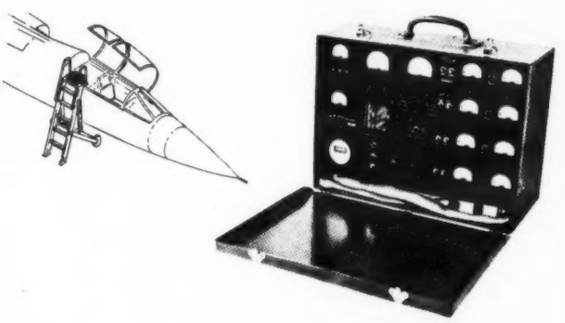


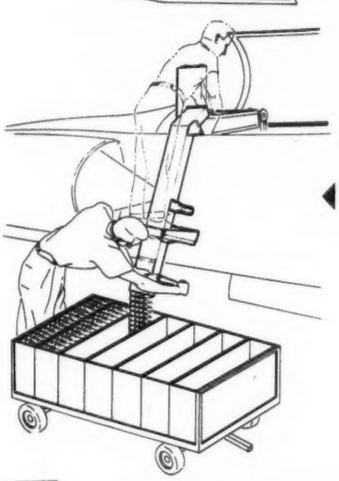
The J79 jet engine, mounted on an adapter, can be transported by standard trailers. The same adapter is used for mounting the engine on the workstand for repair purposes. A similar stand is used for the afterburner.



Hoisting gear mechanism operated by a hand crank to move the gun mechanism laterally into the armament compartment, raising or lowering it as required.

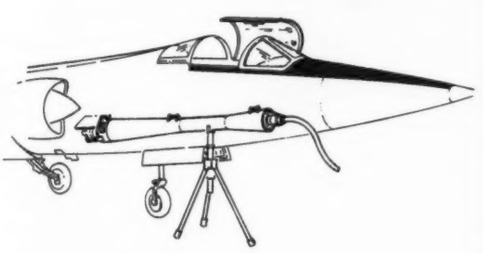
Three-axis damper amplifier analyzer uses simulated signals to check the functioning of the stability augmenter system, without removing system components from the aircraft. Similar test sets have been developed for the cabin air-conditioning, the optical portion of the gun sight, radar equipment, etc.

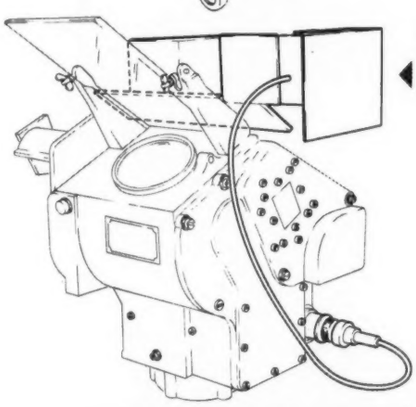




Ammunition loader, hand crank operated, enables ammunition can to be reloaded without removal from the aircraft. Both ammunition and loader are transported to the aircraft by trailer.

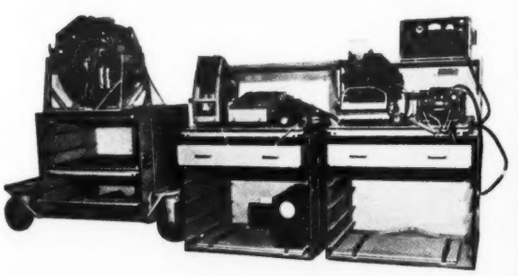
The ram air turbine, unfolded from the side of the fuselage, is checked by means of this adapter, which is equipped with air speed and temperature gauges to supply a carefully metered flow of air to the turbine. The adapter receives compressed air via a hose.



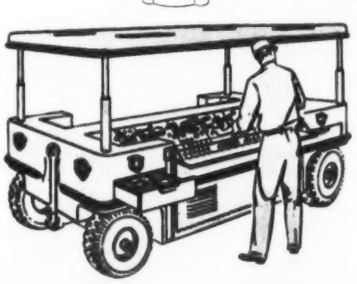


The lead angle of the gun sight is checked by means of this fixture which aligns the mechanical and electrical caging positions, checks the function and balance of the gimbal system, lead angle and reticle size.

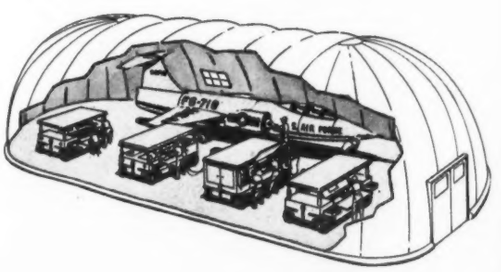
Portable three-piece test bench set, on wheels, for maintenance of the fire control system. The ASC-14 fire control system is shown mounted on the left-hand cabinet, while the centre and right-hand cabinets carry indicators, the F-104's gun sight and various test equipment.



Mobile maintenance trailer for the F-104's fire control system. The top can be raised to serve as maintenance platform or as stand for the crew chief.

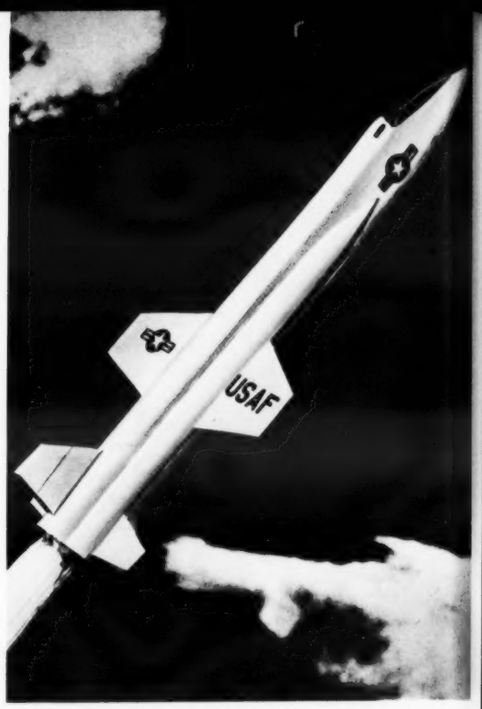


Inflatable air hangars (40 × 80 ft.) are proposed by Lockheed to shelter an F-104, together with the majority of its mobile ground support equipment. The vinyl-coated nylon shelter is held erect by 2 p.s.i. of blower-supplied internal air pressure, and kept in position by bags filled with sand or water. Double plywood doors provide access.



Multi-purpose armament ?

One Hundred Miles up at Mach 7



Drawing of the North American X-15 piloted research vehicle, powered by a Reaction Motors Inc. liquid propellant rocket motor.

In September 1956, Captain Ivan C. Kincheloe piloted the Bell X-2 rocket-powered research aircraft to an altitude of 126,200 ft. and almost reached the outer limits of the earth's atmosphere. At this height he was above roughly 99 percent of the earth's atmosphere. After burnout of the rocket motor which had powered the X-2 at high Mach numbers up into the thinnest air layers, Kincheloe maintained the aircraft in a ballistic trajectory up to the record altitude, and then curved down into the heavier air layers. Up to the present time this has been the highest projection of a piloted aircraft into the upper atmosphere; for some 50 seconds Kincheloe experienced a period of zero gravity, but without any serious effect on the performance of his control functions. This and other experiments with rocket-powered research vehicles (Bell X-1A, X-1B, X-1E, etc.) has only been the preparatory work for far reaching and more hazardous undertakings to take man to an altitude of over 100 miles, and finally to permit him to circle the earth on the fringe of space.

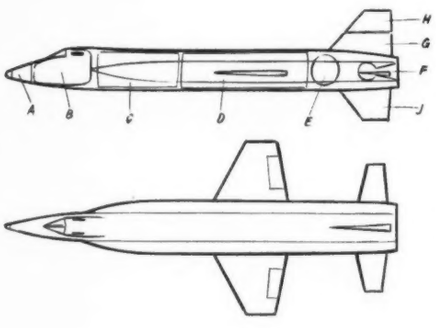
Back in 1952, when the Bell X-1A, Bell X-2 and Douglas X-3 were first built, the U.S.A.F. and N.A.C.A. were giving their concentration to the conditions of flight at extreme altitudes and at speeds in excess of Mach 5. After highly promising preliminary study, the U.S.A.F., the Naval Bureau of Aeronautics and N.A.C.A. undertook a joint project for the development of a rocket-powered aircraft to be built within the framework of a common research programme undertaken by the three organizations. N.A.C.A. took over the technical direction, while the U.S.A.F. became responsible for finances, and for the control of the development and construction work. Finally the U.S. Navy allocated further funds and made available certain test and experimental equipment. At the end of 1954, a design competition was announced, and in due course, in November 1955, North American Aviation Inc. was awarded a contract to build the selected experimental aircraft, which was to be powered by a Reaction Motors Inc. rocket motor. The first steps towards the realization of the project had been taken.

Quite early in the first phase of the project, it became evident that the X-15 would be called upon to carry out a far wider range of experimental work than had originally been envisaged. The experiments which were at that time being conducted on a planned I.C.B.M. showed that much was left to be desired in the questions of reliability and accuracy. The military planners then looked for a new solution to the problem of providing an accurate, multi-purpose weapons system, with global range . . . and turned to the piloted glide bomber. Launched with the aid of booster rockets, and brought to a great height, such a vehicle could, at the end of the ballistic trajectory, enter upon a long distance glide; during this glide flight the aircraft would circle almost the whole of the earth's surface and, as and when required, could utilize its own power unit. Thus, at a given moment, the crew could launch their atomic warhead payload with a high degree of accuracy against the selected target (cf. *Interavia* No. 3, 1958, page 244). This type of vehicle could also be employed for reconnaissance duties, for defence against attacking missiles and, by no means last, for transportation. With U.S.A.F. support, Bell, Boeing and North American are already engaged on global glide bomber projects, and Douglas and Republic have also been named in this field. It is very clear, however, that development of such a new weapons system brings many problems in the fields of aerodynamics, thermodynamics, stability and aero-elasticity. The X-15 is the most important piece of research equipment towards the realization of the global glide bomber concept, and it is particularly significant that up to the end of 1957 the U.S.A.F. had allocated no less than $50 million for this research aircraft.

What does this piloted space vehicle look like, and how does it differ from its less revolutionary predecessors? Briefly, the only basic similarity to the X-1 and X-2 is the concept of a long, pointed fuselage, packed with propellants for a rear-mounted rocket motor, and carrying a small pressure capsule in the nose to house the pilot. For the rest, a description of the X-15 reads like an extract from popular space fiction magazines or from the pages of Jules Verne. But in fact this is now all sober reality—from the jet nozzle flying controls, the inertial guidance system, down to the pilot's full pressure suit. Two prototypes are currently being built, and the first will make its first flight before the end of this year. A third prototype is planned.

The accompanying sketch gives an impression of the layout of the X-15. The nose *(A)* of the long, steel fuselage carries various instruments housed in a presumably spherical

Schematic drawing of the X-15 (compiled from information available to date).



In September 1956 Captain Kincheloe piloted the Bell X-2 rocket aircraft to an altitude of 126,200 ft.

The D-558-III project, developed by Douglas but later dropped, was for a piloted rocket-powered space vehicle, and employed a more conventional design concept than the X-15.

container. Further back, the pressure cabin *(B)* provides the pilot with adequate forward visibility, but lateral visibility is limited by small side windows; the cabin carries air conditioning plant and the pilot's oxygen supply. Behind the cockpit are two propellant containers *(C)* and *(D)* which are reported to be fitted with vertical separation baffles to counteract the surge of the liquid propellant in flight. At the rear of the propellant containers is a spherical container *(E)*, supplying pressurized gas for propellant feed. Installed right aft is a Reaction Motors Inc. very accurately controllable rocket motor *(F)*, which will deliver a maximum output of about 60,000 lb. thrust. The dorsal fin *(G)* at the rear of the fuselage has a wedge airfoil and the upper portion *(H)* forms a rudder; the trailing edges of both fin and rudder are said to be no less than 12 inches thick. The ventral fin *(I)*, which is jettisoned before landing, the horizontal stabilizers, and the trapezoidal planform main wing all have wedge airfoils. To reduce interference drag between the fuselage and the wing, North American has opted for a mid-wing design and the wings are mounted in two long triangular-section bulges running from cockpit to the rear of the fuselage. These beryllium bulges also house all cables, controls, linkages, etc. and provide additional lift.

The short trapezoidal wing incorporates ailerons in the centre of the trailing edge. For roll control during the ballistic phase, two jet nozzles, directed upwards, are fitted near the wing tips; the nozzles are probably fed with hydrogen peroxide steam and are controlled by a common differential valve. Control about the vertical and transverse axes during the ballistic phase is also effected by means of jet nozzles; for yaw control there are two horizontally mounted jet nozzles, and for pitch control two jet nozzles are mounted above and below the fuselage nose. The jet control system for roll, yaw and pitch is currently being tested out on a Bell X-1B research vehicle. The North American X-15 is approximately 50 ft. in length, has a 22-ft. span and, with full fuel load, a gross weight of between 32,000 and 33,000 lb.

The probable flight plan for this piloted, winged rocket is shown in diagram A herewith and, in general outline, will be similar to that for the X-2 (diagram B). However, it has not yet been decided whether the glide path following the ballistic flight (to counteract the vehicle's high kinetic energy during re-entry) should be slightly curved, almost flat, or alternatively should follow the skip method of a rising and falling curve. The critical factor is the high frictional heat generated during re-entry; if the re-entry angle approaches the vertical, as in the case of the V-2, the vehicle's nose would undoubtedly melt, and even with the planned very shallow re-entry path, surface temperatures of over 500 °C must be expected. The question now under discussion is whether repeated re-entry and exit (i.e., the skip method) will result in a lower structural temperature than can be expected from a continuous, shallow re-entry glide. Scientists at N.A.C.A.'s Ames Laboratory hold the opinion that the skip method will give rise to greater heat build-up. They claim that the frictional heat generated on re-entry into the atmosphere will not be reduced so effectively by repeated jumps back into space where the absence of surrounding air will not permit convection of the heat; they believe that a long, continuous glide flight into increasingly dense layers of air will permit greater cooling by utilization of convection as well as radiation. On the other hand, other experts maintain that during repeated skips the structural heat will be more evenly dispersed over the entire surface of the vehicle, and that equilibrium temperatures, after a given time, will be lower than in the glide method. The first launchings of the X-15 into space will show which is the better method.

In the meantime various re-entry paths are being calculated on N.A.C.A.'s analogue computers in order to prepare this most important part of the X-15's flight schedule. The pilot will have direct control only over the direction, height and speed of the re-entry approach, and the rest will be achieved by automatic control coupled to the inertial guidance system.

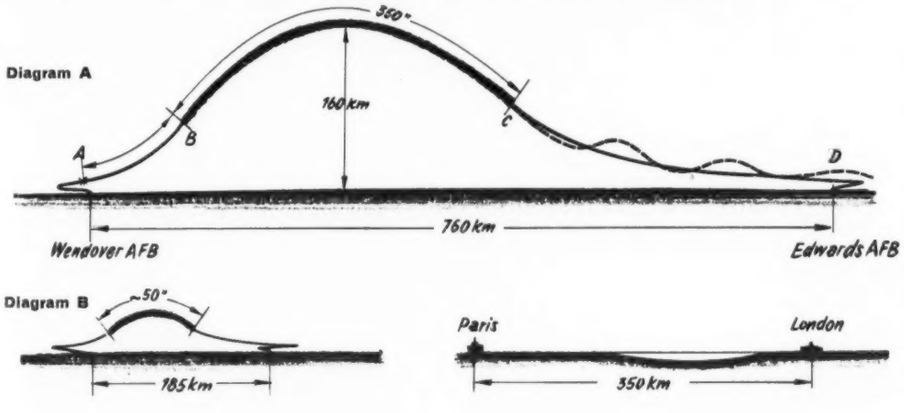
When completed, the first X-15 will be flown by North American's pilot Scott Crossfield to test the vehicle's general airworthiness. At a later stage Captain Kincheloe of the U.S.A.F. will carry out a series of experimental flights to establish the performance limits of the X-15, and further research work will be undertaken by N.A.C.A. pilots Walker, McKee and Armstrong within the framework of the joint U.S.A.F./N.A.C.A. flight programme.

Meanwhile it has been reported that plans are in hand to build a developed version of the X-15, to meet the manned satellite concept, capable of circling the globe and returning to earth. The project has been designated X-15B, and, according to Washington sources, this space vehicle will be powered by the 450,000-lb.-thrust three-chamber booster rockets which were planned to equip the North American SM-64 *Navaho* intercontinental ramjet missile.

It should also be mentioned that Douglas Aircraft Company had also submitted a project for a piloted research vehicle for experimental work on flight at hypersonic speeds; development work, which was begun in 1953, has now been dropped following the withdrawal of U.S.A.F. credits. Designated Douglas D-558-III, the rocket-powered vehicle was intended to have a maximum speed of 6,000 m.p.h., capable of attaining altitudes of up to 750,000 ft., and to be launched from a parent aircraft.

Diagram A – typical X-15 experimental flight plan
From Wendover, Utah U.S.A.F. base a B-52 mother aircraft will carry the X-15 to an altitude of 40,000 to 45,000 ft. before it is launched under its own power (Point *A*). After some minutes the rocket motor will have accelerated the vehicle to a speed of Mach 6 to 7 over an initially gradual, but increasingly steep angle of climb (maximum approximately 40°) up to point *B*. After cut off of the rocket motor the vehicle will have a velocity sufficient to carry it on a ballistic trajectory to an altitude of roughly 100 miles, before commencing to fall back to the earth. The period of zero gravity from *B* to *C* lasts approximately 350 seconds. At this stage the increasingly dense air layers will decelerate the aircraft; aerodynamic control will again be possible to enable the pilot to pull out of the dive. The ensuing glide flight (dotted line in diagram) or the skip manoeuvre will absorb the aircraft's kinetic energy permitting it to be landed at the U.S.A.F.'s Edwards, California base. The glide phase from *C* to *D* will require at least 20 minutes, giving the entire flight an endurance of approximately one hour.

Diagram B – the record altitude flight of the Bell X-2
The experimental flights undertaken by Captain Kincheloe with the X-2 followed a similar pattern to that shown in diagram *A*, but occupied a flight time of only some 15 to 17 minutes, reaching the middle stratosphere. For example, the zero gravity phase of the record flight in September 1956 lasted approximately 50 seconds; the apex of the ballistic flight path was 126,200 ft. For the descent from the apex altitude to a height of 40,000 ft., Captain Kincheloe took 62 seconds, and for the glide flight from this height to touchdown *(D)* approximately 10 minutes.



The Air Hostess Told Us...

Scientific and technical progress is a fine thing, says our favourite Air Hostess, but it's going to mean lots of problems for us girls in the seventies.

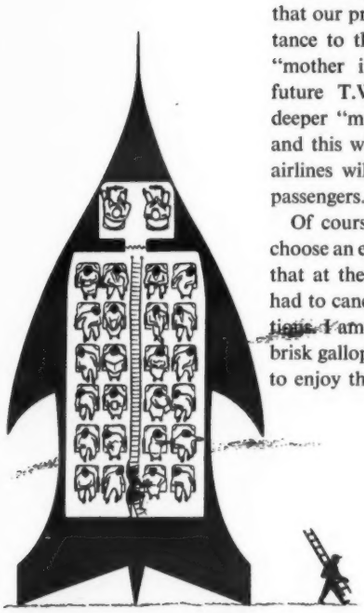
But surely, my dear Esmeralda, you are not worrying about problems which may arise in twelve years time? By 1970 you will probably be married, perhaps even happily, with a Park Avenue address, two minks and a Cadillac.

That's just where you're wrong, says Esmeralda. All this might have come true fifteen years ago when we were using 20-seat aircraft, flying almost empty in wintertime except for the odd business executive or millionaire. In those golden yesteryears a four-hour tête-à-tête with a lone, unmarried V.I.P. was an overture to the Wedding March and the life of a princess. But today, with bigger aircraft, even in the winter we seldom carry less than 10 passengers; what is more, they are not V.I.P.'s, but tourist class passengers whose only offers are highly unoriginal and without regard for a girl's nobler instints. The situation will be even worse when the economy class starts. Times are changing, and already T.W.A. has announced that hostesses who marry will be allowed to continue working for the company. We girls, crescendoed Esmeralda, are being forced into the arms of tourist or economy class passengers, to whom a working wife is a necessity or at least a blessing.

But do you think, Esmeralda, that all the other airlines will necessarily follow T.W.A.'s lead?

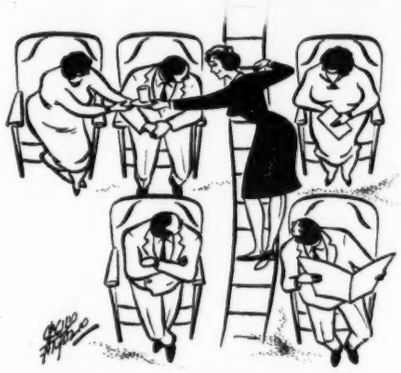
Now listen, retorts Esmeralda. Don't you know that our presence aboard is of the highest importance to the passenger's welfare in view of the "mother image" we represent. Well now, in future T.W.A.'s air hostesses will present a deeper "mother image" than the other airlines, and this will divert traffic to T.W.A.; the other airlines will have to follow suit to regain their passengers.

Of course, when I do marry I shall certainly choose an epidemic-free moment. I well remember that at the peak of the Asian flu' my company had to cancel all rest periods, holidays and vacations. I am not the girl to relish the thought of a brisk gallop from Altar to Airport, leaving hubby to enjoy the honeymoon alone.

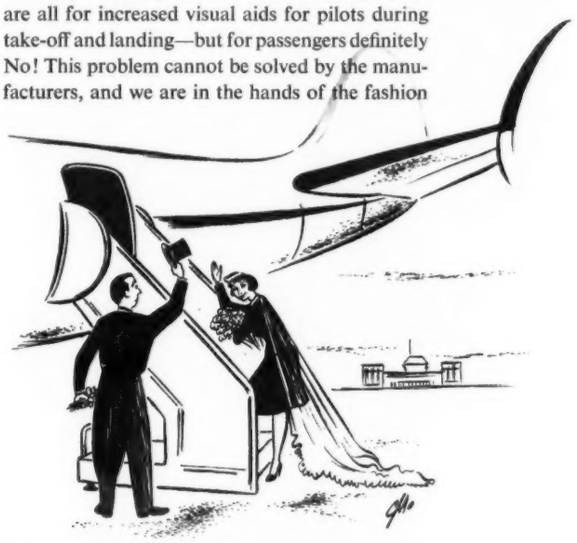


But Esmeralda, we're getting a long way from your problems for the 1970s. What *are* they anyway?

I have read in *Interavia,* says Esmeralda, that one Mr. Hibbard, Vice-President of Lockheed Aircraft Corporation, expects that by 1970 airlines will be operating vertical take-off aircraft (V.T.O.L. to you) on scheduled services. In the girls' room we have decided that seats in these aircraft will turn 90 degrees during take-off and landing to keep the passengers vertical. We also suppose that the airlines will still expect us to check that passengers have fastened their seat belts and to do the rounds with chewing gum



and candy. This will be quite feasible if the manufacturers equip the aircraft with a rope ladder hanging from the cockpit door. It is at this stage of the proceedings that our worries begin; we are all for increased visual aids for pilots during take-off and landing—but for passengers definitely No! This problem cannot be solved by the manufacturers, and we are in the hands of the fashion



designers who must supply us with a new (don't) look—a V.T.O.L. line! If the V.T.O.L. aircraft were here today the problem would probably not arise; but fashion changes, and who can forecast what the well-dressed hostess will be wearing in the 1970s—it may even be the bell skirt again! And please, *please,* don't suggest slacks—many tourist and economy class bachelors don't care for wives who wear the trousers, and after all, we must do our best to please...

Numerical Control and Automation

By M.C. Copold, Numerical Control Coordinator,
Convair (San Diego) Division of General Dynamics Corporation

When we consider automatic control today, we must remember that there are two definite and distinct types, the older of which is the *analogue*, and the newer is the numerical or *digital* type.

Let us first consider *analogue control*. The word analogue, according to Webster, means: "that which has some resemblance to, or corresponds to something else". This "copying" type of automation is usually of a mechanical nature and is widely used in the sales-manufacturing type of industry; for example, the automotive industry uses machines which can completely drill and bore or tap a complete engine block in a single cycle of motion, even the inspection of the completed part being carried out by a form of analogue automation. It may be recognized therefore that analogue automation is the type which is being used to satisfy the requirements of high production.

However, this type of automation does not readily lend itself to change. Quite frequently the change of one hole in an engine could mean the scrapping of the machine tool used to make it, but this is not too important since the automotive industry is basically a sales business, and in this type of manufacturing decisions on engineering and tooling do not normally arise concurrently with production. The design and tooling task is sometimes completed one or even two years prior to the start of the production process.

In the *aircraft industry*, however, it is not uncommon to have many hundreds of changes for every unit produced, and these changes have to be operated concurrently with manufacture. Within our factory we must therefore remain flexible and be able to absorb changes on a day-to-day basis.

The impression must not be given that analogue automation is something which has no place in the airframe industry, for many of our machines are operated by this method and, for example, Convair was the first to successfully operate an analogue tape-controlled riveting machine. For over a year, day in and day out, the machine produced wing panels riveted by this form of automation without ever producing a single piece of scrap, and with a minimum of down time for maintenance. Our large spar mills are template controlled, and we use tracing lathes, Hydrotels and Kellers, all of which are analogue machines. Such machines are also used in our production processes.

*

However, let us consider the current aircraft manufacturing problem. Insofar as they still have fuselage and wings, modern aircraft externally resemble those used in World War II, but have entirely different missions, speeds and complexity, never previously encountered in the industry, and are built to tolerances which one would usually expect to find in the mechanism of a Swiss watch. In the building of World War II aircraft it was feasible to utilize a composite type of structure for all the load bearing elements, and for example a spar or bulkhead would be made up of bits and pieces of metal riveted together. This was acceptable since these components met the requirements of economy and strength-to-weight ratio demanded by the operational specifications; however, these specifications have changed and with today's higher altitudes and greater speeds the internal structure of the aircraft has resolved into elements comprised of larger homogeneous masses. At Convair, for example, we have spars with a finished weight of 76 lb. which are carved out of a single 16,000-lb. aluminium alloy billet; in this case, more than 95% of the material is machined away to produce the finished part, and this is one of the major problems in airplane manufacture today. With the introduction of the heavy press program and large forgings, this waste of material has been relieved to some extent, and the amount of scrap machined away in order to produce finished parts will be reduced. However, in most cases the overall machining task still remains, and the problem poses a requirement for 100 percent precision machining. There is no analogue system known to man capable of efficiently producing this category of parts.

In order to obtain 360° of control, it is necessary for the analogue control to operate in three axes of motion which must be synchronized. This presents an interesting problem in cam coordination which would make the introduction of a normal change extremely difficult, expensive and time consuming.

Recognizing this problem, the aircraft industry is looking to *numerical* or *digital* control as the type of automation to provide the solution. A system for the numerical control type of automation as applied to machine tools has been developed in this decade at the Massachusetts Institute of Technology and has successfully demonstrated its capability for economically and rapidly translating man's ideas and designs into three dimensional hardware. This project is a pioneer, and like all pioneers it is by nature rough and primitive.

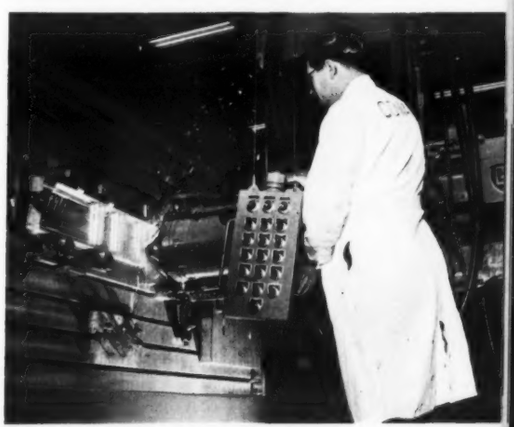
The introduction of the numerically controlled machine into current manufacturing processes presents some problems, the foremost of which is programming, or the art of translating engineering dimensions into the language of the machine. It is probably safe to say that no human being possesses the degree of intelligence necessary to prepare a single complex part program efficiently, and it is necessary to accomplish this by a composite technical team. To overcome this in the future we must rely on our educational institutions to provide the new technology in the form of required training for programmers to handle the data conversion problem.

But despite the difficulties encountered in introducing this system into current manufacture there is much to be gained; for example, since the operating data are numerical, any degree of accuracy can be obtained up to the limit of the machine tool itself. An additional .005 of an inch in thickness means approximately one extra pound of weight in 15 square feet of aluminium, and this factor is higher in steel and titanium; if we further consider the thousands of square feet of machined surfaces in a single aircraft, it is clear that finer tolerances would result in a tremendous saving in weight which, in turn, would mean improved performance and efficiency.

*

How does numerical control function? All dimensions from engineering design drawings are converted into coordinates related to a definite point of origin, and then translated into binary numbers or numerical code. The numerical code can be arranged on a tape to depict the sequence of operations or motions on a machine with a similar

In this numerical director unit the work-piece coordinates and machine data punched in series on a paper tape are automatically transferred in parallel to a 7,200-ft. magnetic program tape to be used for control of the workshop machines. The magnetic tape has 14 parallel command channels and carries the entire program instruction for the manufacture of one aircraft part.



Supervision of this numerically controlled profile milling machine (Gidding & Lewis, Fond du Lac, Wisconsin) is effected by means of two control panels: one, a mobile unit pictured in front of the operator, or the second (not shown in picture) directly connected to the electronic section at the side of the machine. This work-piece is a part for the Convair F-102A interceptor.

point of origin. The tape containing the program is fed to the electronic director where, by means of a photo-electric tape reader, the numerical values are converted into electronic pulses by count; these impulses are stored in the director's memory for use as required by the machine servo motors. Impulses are distributed to the respective servos, whose signals are amplified for the operation of response servos on the machine actuators; data are measured by means of feed-back and, as this is a closed loop system, control and correction are continuous and automatic.

Although the director is designed to operate the machine in the manner just described, it is more practical to record the dimensional signal on a magnetic tape; this divorces the very expensive director (price over $ 200,000) from a single machine and permits it to prepare programs for any number of other adaptable units.

*

Let us now consider the most important problem of all. Modern aircraft production as currently outlined by the U.S.A.F. requires that weapons be designed and tooled for production, be built at a low rate, thoroughly tested under all environmental conditions, and delivered as operational weapons to the using command. This policy is sound but requires inherent flexibility in manufacture, and it is conceivable that numerical or digital control, properly established in the specific field of automation, will help to meet these requirements. Part complexity will not affect machine operation, set-up time can be reduced, scrappage of parts avoided and time saved. With numerical control 360° machinability is possible in a maximum of two set-ups, and this is a great simplification in time and tooling cost.

Today the machining of forgings presents a major problem throughout the airframe industry, and it is our first immediate field to be considered for automation. This is necessary in order to remain flexible, to be able to process changes quickly, and to remove the element of human error. We all can recall the time when the machine was completely subservient to man, but during the last twenty years man has become subservient to the machine because it moves too fast for his physical reflexes and mental capabilities.

*

How can automation serve the aircraft industry? To sum up, it must be remembered that automation is an all-inclusive term. In our business we need that phase of automation which helps us. Unlike the sales type of manufacturing we do not need to move a million identical parts per year through a complex manufacturing process untouched by human hands. This type of automation has been developed, and will be further developed, and the aircraft industry will spin off what can be used effectively just as it has done in the past. We do need, however, the genius and flexibility of numerically controlled automation to handle the changes reflected in three-dimensional hardware faster, cheaper and more accurately. This is the field of automation on which we, in the aircraft industry, are working and which we need and look forward to.

Digital Computers in the Aircraft Industry

By H. McG. Ross, M.A., A.M.I.E.E., Ferranti Ltd., London

The major British and North American aircraft companies have electronic digital computers, and almost all the others use these machines on an hourly-hire basis. There is such an extensive use of these centres that they are generally run on a shift system, some of them round the clock. The customer simply hires time on a machine, either programming the problem himself or having it tackled by the computer organization.

The distinctive feature of a digital computer is that it is prepared for any particular job by means of a programme—a prepared list of instructions or commands to the machine. Any one computer will carry out an immense variety of applications, and yet no change or alteration is made to the machine itself—it is merely supplied with another programme.

It follows that the programmes for any one machine are of major importance, and a well-prepared collection is of immense value—it is in fact the most important asset made available to the user of any one particular type of computer. When a programme exists all the user has to do is to supply the data for his particular problem. This is presented to the computer in a prescribed form (preceded by the programme), the machine is controlled by its switches, and in a matter of minutes or hours the results are typed out in readable form.

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The interrelation of man and machine is of great importance in the organisation of computer groups, particularly with reference to writing programmes for new problems, or modifying existing programmes to meet a new requirement.

On the organisation of computer groups there are two schools of thought. One, which may be called the older view, believes in having a central group of programmers to take computing work from a number of departments; the other holds the view that the person with the problem should programme it himself, being trained and assisted by the computer experts. Experience shows that this second method produces the better results. The main reason in favour of a person programming his own problem is that he knows the intricacies of that problem. It takes him a shorter time to learn to use a computer than to explain the problem to a specialist programmer. It frequently

The Royal Aircraft Establishment's *Pegasus* computer at Farnborough *(left)*, whose plug-in assemblies *(right)* reveal the rational design and ensure ease of maintenance.

happens that the problem is misunderstood or not completely explained.

Machines are also becoming easier to use. The Ferranti *Pegasus* Computer, for example, is a machine which is easy to use because it was designed by programmers; it is not a piece of equipment presented to the programmer by the computer engineer. It has been found that at the end of a fortnight's programming course, consisting of lectures and practical classes in which examples are worked through, learners can write their first complete programmes themselves and run them on the machine. It is not long before they are doing useful work.

Moreover, the new automatic coding schemes greatly simplify the use of computers and speed the preparation of problems for them. These schemes make the computer appear as a greatly simplified machine, so that "programmes" can be prepared in a self-evident notation. It is not necessary for the user to acquire the technique of standard programming; he can learn to use an autocode within a day or two. This means that far more people can use a computer, and the total time taken to solve a new problem is much shorter. These schemes are a most important recent development in digital computers.

*

All these factors have contributed to the rapid expansion in the use of digital computers—the versatility and scope of these machines have been proved, and a latent demand for computation has been revealed. It is interesting to note that the aircraft industry is the first to make full use of electronic digital computers.

The principal digital computers at present in use in the British aircraft industry are:

English Electric Deuce
Royal Aircraft Establishment, Farnborough (2)
Bristol Aircraft Limited (2)
Short Brothers & Harland Limited, Belfast
English Electric Company Limited (2)

Ferranti Mark 1
A. V. Roe & Company Limited, Chadderton, Lancs.
Armstrong-Siddeley Motors, Limited, Coventry

Ferranti Pegasus
Hawker Aircraft Limited, Kingston
Sir W. G. Armstrong Whitworth Aircraft Limited, Coventry
Royal Aircraft Establishment, Farnborough
Vickers Armstrongs (Aircraft), Limited, Weybridge
De Havilland Aircraft Company Limited, Hatfield
Blackburn and General Aircraft, Brough

IBM 650
Rolls-Royce Limited, Derby (2)

*

In the first place these computers have been used for tackling some of the large-scale calculations which arise in aircraft design. It was immediately apparent that these machines could take over and improve upon work which was previously done by numbers of computing staff with desk machines. A most important development has however occurred: whereas in the past these large calculations (which might take several months to complete) could only be embarked upon occasionally, it is now found that with electronic computers which can do the same work in a matter of hours, much more computation is done. Instead of computation being used merely as a final check to the design, it can be used as a design tool. For example the complete stressing of an aircraft wing or other major assembly can be worked out in 3 or 4 hours, starting from the primary data and finishing with the complete stress distribution. If the initial design is found to be over or under-stressed, the designer can change some of the dimensions and have the modified stress distributions by next day.

More recently it has been found practical to put on these computers a wide range of quite small calculations, of the sort which are done all over the design office. Not only are accuracy and speed greatly increased, but also it is found that the process of preparing these individual jobs for the computer serves to show their interrelation, so that they are more readily seen as part of the whole design process. It is particularly for this latter type of work that it is important that a computer should be easy to use, and that efficient autocoding schemes should be available, because then the engineers can themselves prepare their work for the computer.

*

Because of the volume of computation to be done within the aircraft industry the Society of British Aircraft Constructors set up an Electronic Computer Panel in 1952 with the main purpose of ensuring that calculations common to many companies should be presented in an agreed form, so that programmes written for these problems could be generally applied.

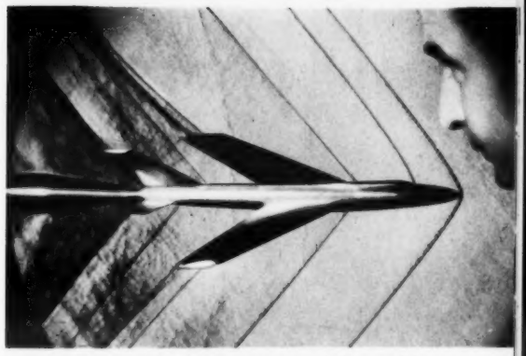
The panel has met regularly since 1952, and at least a dozen of the more important types of calculation have been written up into standard forms. These cover the forced oscillations of the aircraft in flight, flutter, aeroelasticity, the wave drag of an aircraft at supersonic speed, stressing calculations of major components of the aircraft, etc.

*

It will be noticed that a major part of the computing work done in the British aircraft industry is carried out on the *Pegasus* computer. Programmes for all the problems are available for this machine. All *Pegasus* computers are alike so that work prepared on one machine can be run on another, and there is an effective degree of collaboration between the users of this machine so each may benefit by the work of others. The magnitude of this work, the variety of problems being tackled, and the rate at which *new* programmes are being prepared constitute a remarkable modern development in the British aircraft industry.

Not only is there this great versatility in the use of digital computers, but it is also surprising to see the magnitude of the use of established programmes: many of these are being used hundreds of times a year. Thus, at A.V. Roe & Co. Limited, programmes for aerodynamic derivatives have been used 566 times, taking a total of 207 hours; one on loading distribution 480 times (96 hours); anti-icing heat flow 536 times (86 hours); take-off and landing performance 780 times (13 hours); analysis of wind tunnel data 1,864 times (109 hours).

The aircraft industry is a natural user of digital computers, which have become an essential part of the design process of the up-to-date firm. The period of exploration of the use and potentiality of these machines has now been passed, and we have reached the stage of their widespread exploitation.



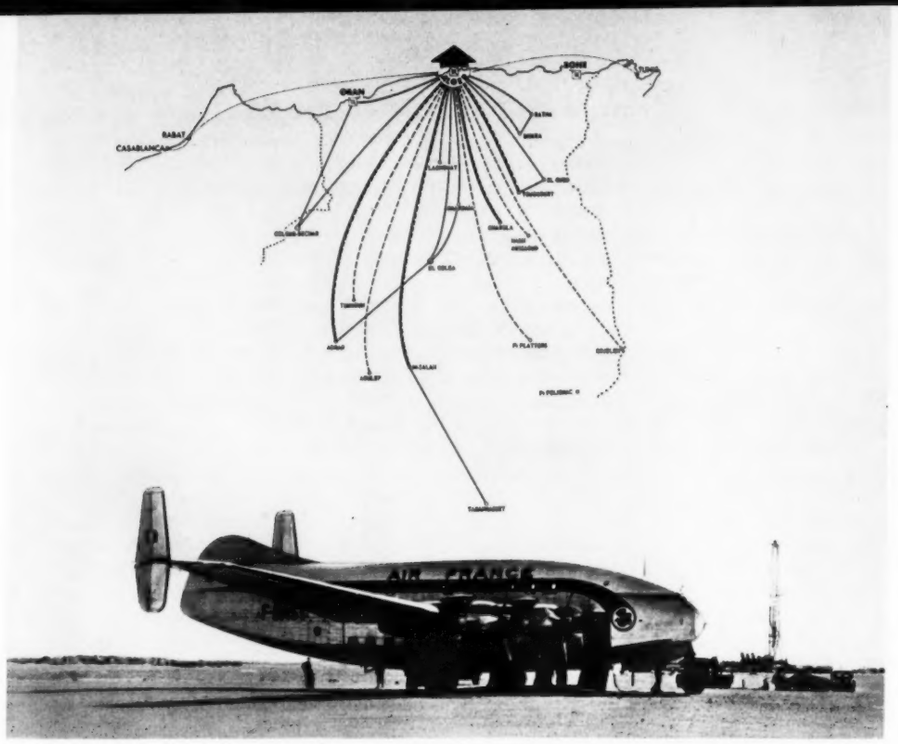
A model being tested in the supersonic wind tunnel to determine its aerodynamic qualities at high speeds. Stresses encountered as it passes through the transonic range are transmitted by strain gauges. After conversion into digital values...

... the test data control a relay tape puncher. The punched tape...

... is then fed into one of the two inputs *(rear)* for the *Pegasus* computer, which...

... calculates the stress distribution. The result is punched on tape *(right)*, which in turn is fed into a Flexowriter *(in foreground of preceding picture)*. In this way the results of a test are available within ten minutes of its completion.

France's Airlines Conquer the Sahara



An Air France *Deux Ponts* at the Hassi-Messaoud oil centre's airport, and Air France's Sahara route network: heavy lines = scheduled services between regular points of call; broken lines = scheduled charter services; thin lines = connections to Morocco and Tunisia.

When Marshal Lyautey said, some forty years ago, "En Afrique on ne voit jamais assez grand" (In African affairs our vision is never broad enough), he will doubtless also have been thinking of the difficulties involved in opening up this vast territory. One region which has always presented particular development problems is, for obvious reasons, the Sahara; the ancient Romans invested considerable funds and efforts in settling the area—not without success incidentally, since the North Sahara under the Roman proconsuls reached enviable heights of colonial development. Yet all that has come down to posterity is a series of Baedecker ruins; and the Romans' Latin descendants—Italians during the thirties, French today—have had to start again from scratch.

The task of developing the area became more attractive when systematic geological survey of the Sahara was undertaken. Up to World War II, however, this had remained more or less "academic," and it was not until the foundation of four prospecting companies (in 1946 and 1953) that the astounding results confronting us today were achieved: an oil and uranium rush which could compare with the gold fever in America a century ago, were it not for the thorny problem of transportation. In view of the scarcity and costliness of ground transport, the airlines must here perform pioneering work. In the Sahara air transport does not merely supplement existing means of communication but, for the overwhelming majority of travellers and a good percentage of freight, it is the only possible solution.

Air France in the sand dunes

A glance at the map reveals the difficulties with which air transport planners in the Sahara must contend. The larger cities—Algiers with 700,000 inhabitants, Tunis with 400,000, Oran with 300,000, Dakar with 300,000, Khartoum with 100,000, Fort Lamy with 40,000, etc.—all lie in a wide arc on the outermost periphery of what by European standards is a virtually "uninhabited" region. The area in which France is interested is more than three times as big as France itself, but has a population of only some 15,000 Europeans and 820,000 Africans, fifty percent of the latter being nomads. A considerable percentage of the European administrative officials, military, engineers and prospectors also lead an "unsettled" existence, constantly on the move from one garrison to another, or from one drilling site to another. With the exception of Colomb Béchar, which has 5,000 European residents, the European colonies in the various oases and mining centres never exceed 400 to 600 persons. There is thus only a very limited "fixed clientele" for scheduled air services.

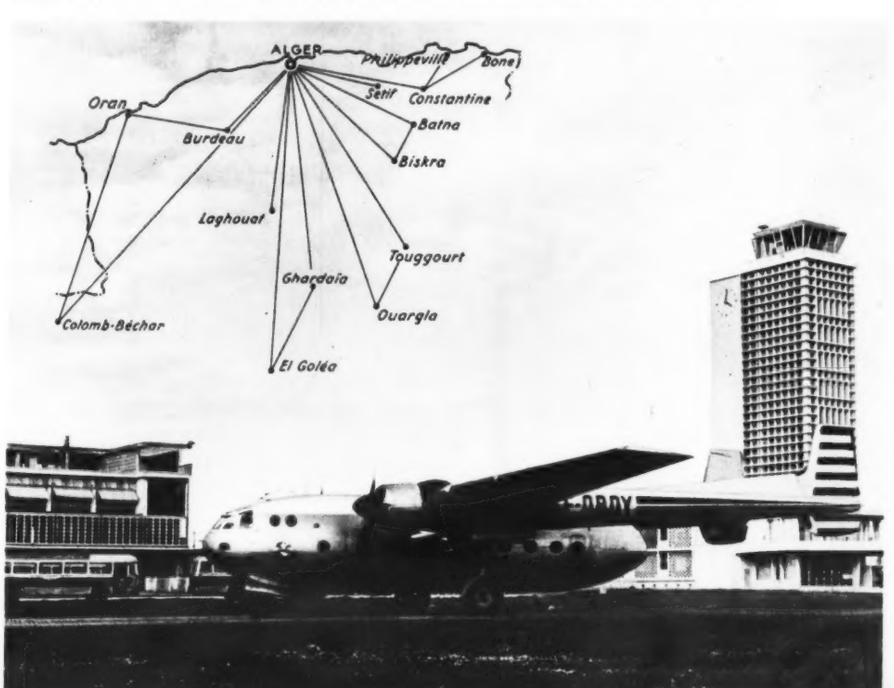
In view of these conditions, Air France operates, in addition to its long-range services between Metropolitan France and Africa, *two types of Sahara service*:

(1) *Scheduled services* between regular points of call, mostly in the North-South direction, radiating from Algiers;

(2) A kind of "*scheduled charter service*" for the oil prospectors, in which it is less important to provide regular service to given points than to meet constantly varying requirements.

Air France's *Sahara fleet* consists primarily of Douglas DC-3s, DC-4s and Breguet *Deux Ponts*. The *Deux Ponts* act chiefly as "flying ships of the desert" and carry freight of the most varied kinds: drilling tools, trucks, refrigerator cham-

An Air Algérie Nord 2501 *Norallas* at Algiers airport, and C.G.T.A. Air Algérie's Sahara route map.



bers, prefabricated houses, etc., while the DC-4s are used mainly for passenger services on the more heavily travelled routes: Algiers—El Goléa, Algiers—Colomb Béchar, Algiers—Biskra. The 21 aircraft stationed in Algiers fly an average of 7 to 8 flights daily on Sahara services.

Traffic volume, which was limited to one or two passengers per flight before the war, has climbed steeply during the past six years:

Air France's Sahara traffic

	1952	1953	1954	1955	1956	1957
Passengers	3,584	8,175	15,355	20,816	31,828	57,365
Freight (t)	3.2	275.7	777.9	1,215.1	1,922.7	4,344
Mail (t)	0.8	9.7	48.3	49.1	91.1	143

In the course of these six years, passenger traffic has multiplied by 16, freight by 1,350, and mail by 178. An example of how far mining and oil prospection has affected this rapid rise is provided by the service between Algiers and the Edjelé oilfield, opened up near the Libyan border early in 1956: in December 1956 a total of 131 tonnes of passengers and freight was carried on 11 flights; in December 1957 the figures had risen to 279 tonnes on 18 flights. In other words, traffic had more than doubled within a year after the first drilling had been taken into operation. Similar results are reported for most of the oil centres.

Small wonder that the share of scheduled charter operations in total traffic has rapidly increased. In 1957 the following results were recorded for scheduled services: 1,015 flights over a total distance of 719,818 km, with a transport performance of 2,764,837 tonne-km. The corresponding figures for scheduled charter traffic are 306 flights, 696,630 km, and 3,926,838 tonne-km.

Unloading a refrigerating chamber from an Air France Breguet *Deux Ponts*.

C.G.T.A. Air Algérie

One of the many airlines sponsored by the shipping companies. In general, shipping lines seem to be by no means unsuccessful when they take to the air. This is certainly true of C.G.T.A. Air Algérie, the airline jointly owned by Compagnie Générale Transatlantique and Compagnie de Navigation Mixte. The company was so to speak born into the incipient boom in Sahara traffic.

C.G.T.A. Air Algérie resulted from the merger of Air Transport and Air Algérie on May 23rd, 1953. During the first seven months of its existence it carried 65,715 passengers and 715 tonnes of freight. In 1954 a total of 105,139 passengers was recorded, and the next year 164,000.

The following table reveals the growth in traffic volume during the past two years:

	1956	1957	Increase %
Passengers	232,469	328,317	+ 41
Passenger-km	215,058,787	288,955,660	+ 34
Freight (kg)	2,928,243	4,543,290	+ 55
Mail (kg)	607,259	1,121,651	+ 85

Air Algérie's *fleet* today (January 1st, 1958) comprises two Lockheed *Constellations*, seven Douglas DC-4s, three DC-3s, two Nord 2501 *Noratlas*.

The *route network* in 1957 included not only Algerian domestic services, but also a number of cities in Metropolitan France and, on several occasions, Geneva.

The above brief account gives a general outline of the development of French Sahara traffic. The picture is completed by the photographer far better than by a 1,000-word article.

You can confidently entrust yourself and your baggage to these sons of the desert, tamed by Air Algérie.

"Main airport building" at Hassi-Messaoud.

At Ghardaia airport: traditional clothing in modern setting.

Gourmets' rendez-vous... the airport restaurant.

What's in the Air?

Extracts from Interavia Air Letter, *daily international news digest, in English, French and German. All rights reserved.*

also with Italy. However these negotiations are still in an early stage, and no official announcement has been made.

● **Junkers Flugzeug- und Motorenwerke,** which had formerly been State property and heavily in debt to the Third Reich, has now passed into private ownership. The firm has been acquired by Flugzeug-Union Süd GmbH. with headquarters in Munich. Flugzeug-Union Süd is jointly owned by Ernst Heinkel Fahrzeugbau GmbH., Speyer, and Messerschmitt AG., Augsburg. At the same time a new management and a new Board have been appointed. Hans Frisecke and Dr. Ing. Fritz Gosslau (who was formerly with Heinkel) have been appointed Managers. The Board of Directors includes the following: Chairman—Fritz Rudorf (Hamburg), Manager of Deutsche Bank and formerly Manager of Bank der Luftfahrt; Deputy Chairman—Dr. Dietrich Westermann (Bonn); other members—Hans Keilholz (Frankfurt); Heinz Kirstein (a Hamburg lawyer); Alfred Klein (Stuttgart), Heinkel; Prof. Alfred Quick (Aachen), Deutsche Versuchsanstalt für Luftfahrt; and Dr. L. S. Rothe (Bad Homburg), Messerschmitt.

U. S. Defense Secretary Neil H. McElroy (left) has appointed Roy W. Johnson as Director of the Pentagon's Advanced Research Projects Agency. Johnson was formerly Vice President of the General Electric Company.

E. Allan Williford (left) has given up his activity as President of Link Aviation Inc., but he will continue to be a member of the Board of Directors. David D. Mason, a former Vice President of Link, has been elected the new President.

AIR TRANSPORTATION

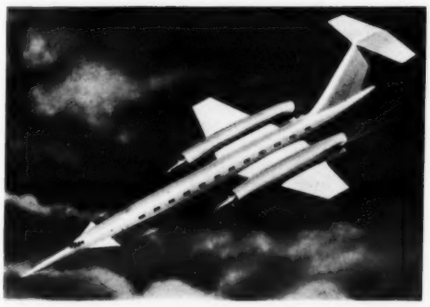
● **Alitalia, Linee Aeree Italiane** has decided to place an order for four Douglas DC-8 jet airliners. The Board has also approved the sale by Istituto per la Ricostruzione Industriale of a block of Alitalia shares totalling 107,000,000 lire to Piaggio & Co., Genoa. The resignation of Ing. Luigi Acampora has been accepted, and Franco Giazotto, Deputy Director of I.R.I., has been elected to fill the vacancy on the Board.

● **The Swissair accounts for 1957,** which will be submitted to the general meeting of shareholders on April 2nd, showed revenues amounting to 210,000,000 Swiss francs (compared with 159,000,000 francs in 1956) and expenditures totalling 207,000,000 (as against 156,000,000 francs in 1956), with a net profit of 3,175,450 francs. Payment of a six percent dividend (unchanged) is recommended. A sum of 400,000 francs will be set aside for statutory reserves, and 200,000 francs will go to the pension funds. The balance of 367,057 francs will be carried forward.

● **Aeronaves de Mexico S. A.** intends to take over all the share capital of Guest Aerovias Mexico S. A. which has recently been encountering considerable financial difficulties. Guest has apparently agreed to the proposal and will hand over all its services to Aeronaves: Mexico City–Miami, Mexico City–Guatemala–Panama, Mexico City–Miami–Bermudas–Azores–Lisbon–Paris.

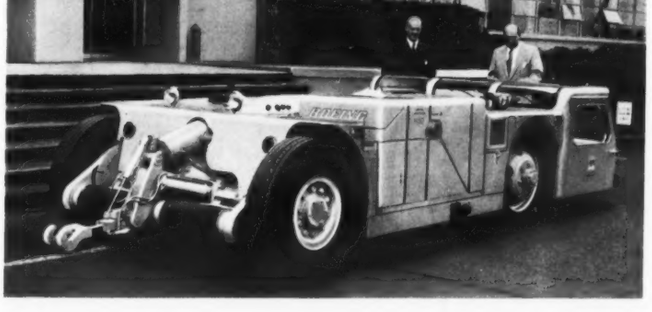
INDUSTRY

● **General Electric J79** jet engine to be built under licence in Europe? General Electric has offered the licence rights to the Federal Defence Ministry in Bonn, because of the interest shown by Germany in the Lockheed F-104 and the Grumman F11F *Super Tiger*, both fitted with the J79. In view of the development of closer collaboration between Germany, France and Italy, it appears that General Electric has opened similar discussions primarily with France and possibly

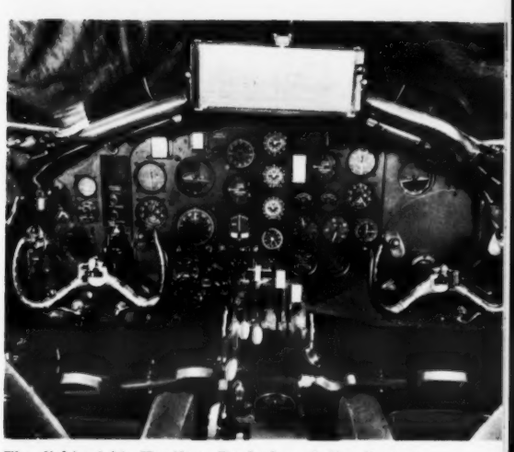


The Georgia Division of the Lockheed Aircraft Corporation has been working for some years on the design of a nuclear-powered long-range bomber (U.S.A.F. designation WS-125A), and has now released two photographs which indicate the lines along which the development is continuing. The development of a long-range civil version (upper picture) shows details of wing-mounted power units, supplementary stabilizers in the nose and a high-mounted tailplane. The development of a long-range bomber version (lower picture) shows four power units mounted on the sides of the fuselage, and a more or less conventional airframe design.

Turbo-Tug, a tug and starter unit for heavy jet bombers which has been developed by Napco Industries, Inc., Minneapolis. Two Boeing gas-turbine engines supply the horsepower (to drive the tug and its friction rollers, and to supply the large volume of air necessary to start the jet engines). Weight of the tug is 8,000 lb., as compared with 40,000 lb. of the standard tractors used up till now.



Twenty-six years lie between the construction of the Boeing *Pilgrim* and the Boeing 707. The *Pilgrim* has only just been retired from regular airline service (on the Alaska Airlines feeder routes), and has been purchased by the Salmon River Flying Service, Idaho.



The lightweight Hunting *Pembrokes* of the German Armed Forces are equipped with Decca Flight Logs.

The French Nord-Aviation Nord 3400 artillery observation aircraft which is destined for French Army units. Through the utilization of devices to improve performance (variable camber flaps, etc.), the Nord 3400 is able to operate from runways of less than 100 yards. Stalling speed 38 knots; cruising speed 108 + knots.

● **Douglas, Boeing and Convair** have, for some time now, been playing with the idea of offering short and medium-range airliners powered by two or three jet engines. The three firms are said to be thinking of standardizing certain components of their four-jet and twin- (or three-) jet models which would simplify purchasing and maintenance. Douglas Aircraft Company's twin-jet design project appears to be in a more advanced stage than the others, and the designation DC-9 has again been mentioned in this connection. The powerplant considered is said to be the P & W J75. It is assumed that Convair will retain the General Electric 805 (civil version of the J79) for its project. The Boeing short and medium-range jet transport will probably be given the designation 727. It has not yet been decided whether the aircraft will be a twin-jet or three-jet model, nor does a choice of powerplant appear to have been made so far.

● **Jack V. Naish** has been elected President of Convair Division of General Dynamics Corporation, succeeding General Joseph T. McNarney. Naish, former Executive Vice President of Convair, was also made a Senior Vice President of General Dynamics. Born in New York City on July 12th, 1907, Naish is a graduate of Fordham University. After eight years with Northrop Aircraft Inc. he joined Consolidated Vultee Aircraft Corporation as Corporate Director of Contracts in September 1949. Less than a year later he was elected Vice President of Contracts. On December 12th, 1952, Naish became Executive Vice President, and he retained the position when Convair merged into General Dynamics on April 30th, 1954. He was elected to the General Dynamics Board of Directors until April 1957, when he was named to the Corporation's Board of Management.

General McNarney, 64, retires as Convair President and Dynamics Senior Vice President, but he will remain a consultant and member of the Board of Directors.

● **The Bristol/Hawker Siddeley combination** is continuing to push the Bristol 200 despite British European Airways' choice of the DH-121. Bristol sales teams are visiting European operators, while discussions are being continued with U. S. airlines, including Pan American and United.

● Several British firms are still working on projects for a *Heron*/DC-3 replacement and for jet executive aircraft. Hunting Aircraft has worked out projects with small ducted fans, turboprops and twin *Orpheus* installations. De Havilland has worked out mockups of a twin *Orpheus* machine, and Hawker Aircraft has produced a project for a high speed executive type based on the *Hunter* wings and tail assembly, and also powered by twin *Orpheus*.

● **Carl Haddon,** Lockheed Aircraft Corporation Chief Engineer, California Division, has been appointed Director of Marketing to replace Leonard Schwartz, who has resigned to join Hughes Aircraft Co. as Vice President. R. E. Bailey, formerly Chief Advanced Systems Research Engineers, succeeds Haddon, with Arthur Flock, Assistant Chief Engineer, replacing Bailey.

A Breguet 765 *Deux Ponts* was demonstrated in the U.S.A., Cuba, Colombia, Peru, Chile and Brazil from mid-January to mid-February. The *Deux Ponts* completed more than 25,000 miles in a total of 127 flying hours. Altogether 495 guests took part in 17 demonstration flights – these included representatives from 28 airlines, as well as from the armed forces. The whole tour was completed without the slightest technical hitch. Only 3.3 lb. of the 3,300 lb. of spares taken along were used. Highlights of the journey: Reception in New York by 200 people, including press and airline representatives and other officials; contact taken up with the Brazilian state company N. O. V. A. C. A. P. which is responsible for the construction of the new capital Brasilia; reception by Brazilian State President Kubitschek in his residence "Petropolis" (our picture: extreme right Managing Director Henri Ziegler and Commercial Director Pierre Breguet). Operating costs per ton-mile for the *Deux Ponts*, calculated according to the Air Transport Association method, are 7.9 cents for a block distance of 1,000 miles. The second picture shows the arrival of the *Deux Ponts* in Santiago de Chile.

AIRCRAFT AND POWERPLANTS

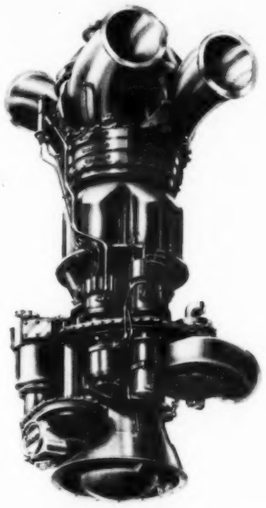
● First flight of the *B-70 (WS-110A)* Mach 3 bomber, under development by *North American Aviation*, is expected to take place in 1962.

● The *small-sized J83 jet engine*, being built by Fairchild Aircrafts' Engine Division at the Deer Park, L. I., plant, has been selected by Canadair Ltd. to power prototypes of the CL-41 basic trainer. Deliveries are scheduled to permit flight testing of the CL-41 by the Spring of 1959. Fairchild also announces that the J83 has been selected to power the Bull Goose, a missile now being produced for the S.A.C. by Fairchild.

● Flight testing of the *SNECMA Atar 9* jet turbine (13,230 lb. thrust with afterburner) is being carried out in the SE.2060 *Armagnac* flying test bed (this is a version which can be equipped with two additional power units mounted below the wing roots). The tests, which are being carried out at altitudes in the order of 39,000 ft., occupy at least three hours flying time at speeds in the neighbourhood of Mach 0.6. The test equipment includes not only instrumentation for direct recording of the engine's performance, but also a set of Hussenot Baudoin recorders which permit in-flight photographic recording of a total of 75 parameters.

The Lockheed F-104A *Starfighter* supersonic fighter is shown for the first time with two *Sidewinder* air-to-air missiles at the wing tips. The F-104A has now entered operational service; the first U.S.A.F. unit to be equipped was the 83rd Interceptor Squadron at Hamilton A.F.B., California.

The first ground tests of the U. S. Army Doak 16 V.T.O.L. research vehicle have been carried out. Designed and built by Doak Aircraft Co., the model 16 is powered by one Lycoming T53 turbine engine; ducted fans on the wing tips rotate through 90° to convert from vertical take-off and hovering to normal flight.



The 920 s.h.p. Napier *Gazelle Junior* turbo powerplant. This power is to be increased to 1,070 s.h.p. in the first stage of development. Napier states that a twin version of the *Gazelle Junior* can also be supplied.

The Canadair CL-66 *Cosmopolitan* fitted with two Napier Eland NEl.6, each of 3,350 e.s.h.p. This latest version of the Convair Liner can carry 44 to 60 passengers, and Canadair Ltd., Montreal, state that the new medium-range transport will be in full production by the middle of 1959.

● The *Aer-Macchi MB.328* executive aircraft, a model of which has now been completed, is to have two 400 h. p. propeller turbines and be equipped with a pressure cabin. Aeronautica Macchi is considering a plan for developing and building the aircraft in collaboration with the French aircraft industry.

● The *Partenavia* factory in Naples has completed work on the prototype *P.57 Fachiro* communications and executive aircraft. Partenavia will demonstrate the P.57 to the Italian Staff for possible use by the Army's Flying Units; the P.57 is a strut-braced high-wing monoplane with fixed nose-wheel undercarriage, and is powered by a 150 h. p. Lycoming 0-320. Three different versions are proposed: a four-seat sports and touring aircraft, a two-seat (side-by-side) version with auxiliary fuel tanks, and a tandem two-seat version for observation and communications tasks.

● Use of European engines for advanced commercial helicopters is now under consideration by design engineers of *DeTemple Helicopters Inc.*, Los Angeles, according to Donald E. DeTemple, Board Chairman. Particular consideration is being given to the possible use of Porsche, Volkswagen and Saab engines. De Temple Helicopters Inc. is currently conducting research and development work on helicopter designs in both the commercial and military fields. Primary concentration is on the development of low-cost single and two-seat helicopters for the commercial market.

EQUIPMENT

● *Collins Radio Company* has officially announced that it is currently developing a transistorised airborne Doppler navigation system for airline use. It was stated that Collins' efforts on its DN-101 Doppler system began in the autumn of 1957. Company spokesmen anticipate flying prototypes in Collins aircraft by late 1958 and models for airline evaluation by early 1959. Production deliveries are expected to begin in the latter part of 1959.

● A *helicopter ground trainer* has been developed in West Germany which, by comparison with complex electronic equipment for this task, will permit the training of helicopter pilots at a very low cost. All patent rights for this equipment have been taken out by the Stuttgart firm of Bölkow-Entwicklungen K.G., who are now working on the development and construction of the first prototype. The apparatus was conceived by Ludwig Hofmann, from 1939—1944 chief pilot with the helicopter manufacturer Flettner, and today associated with Deutsche Helicopter-Dienst Rietdorf K. G. The Hofmann Trainer will be adopted by the latter concern as standard equipment for its helicopter pilot and engineer training school.

● An *optical angle of approach beacon* for use on airports has been developed by Compagnia Generale Progettazioni & Installazioni of Genoa, an associate of Compagnia Generale Elettricita. Designated Fuoco 39-VE, this instrument has the following characteristics: simultaneous emission of three continuous coloured beams covering a horizontal angle of 14°; the lower beam is red, covering a vertical angle of 6°, the centre beam is green covering 2°, and the upper beam is yellow covering 11°; 40 flashes per minute.

● *New hydraulic pumps by Messier:* Société Messier has had three new types of hydraulic pumps certificated:

— Type 2100, rate of flow 4.5 Imp. gals/min at 3,000 p.s.i., 4,000 r.p.m., weight 6.4 lb.
— Type 2103, rate of flow 4.8 Imp. gals/min at 3,000 p.s.i., 3,750 r.p.m., weight 6.6 lb.
— Type 2111, rate of flow 7.7 Imp. gals/min at 3,000 p.s.i., 3,750 r.p.m., weight 10.1 lb.

These pumps are remarkably light, with a weight more than 25 percent less than current models. The type 2100 has successfully completed an 8-hour test run at 5,000 p.s.i. and 6,500 r.p.m.

● *The Rolls-Royce Dart* propeller-turbine has now flown more than 4,000,000 revenue hours powering the Vickers *Viscount*. More than 2,000 *Dart* engines have been built and delivered. The *Dart* started service at an overhaul life of 400 hours and within 18 months, A.R.B. extended the life to 1,050 hours. Since then, the *Dart* overhaul life has gradually been extended and periods of up to 1,800 hours have been approved. Certain *Dart* engines have been run to over 2,000 hours on a trial basis with a view to a further extension of the overhaul life.

Designed to the specifications of leading meteorologists, the Decca primary upper-wind-finding radar Type W.F.1. is the instrument upon which several of the largest and most advanced National windfinding networks are being based. With the design emphasis on simplicity and economy of operation, this Decca equipment offers the latest advances in radar engineering techniques and a very high degree of operational accuracy and reliability. Further working economies have been effected by the introduction of the Decca Radar Reflector System—an inexpensive, efficient method of forming a variety of expendable reflector forms from two standard sizes of triangular foil sections.

Like all Decca radars, Type W.F.1. is backed by an extensive international service organisation comprising over 180 depots throughout the world.

DECCA RADAR serves the world

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LOCKHEED ELECTRA

BASIC DESIGN OBJECTIVE:

Economically Sound— for "Turbine-Age" Short-to-Medium Haul Airline Operations!

Why Emphasis on Sound Economics?

The Airline Enigma—"Profitless Prosperity"

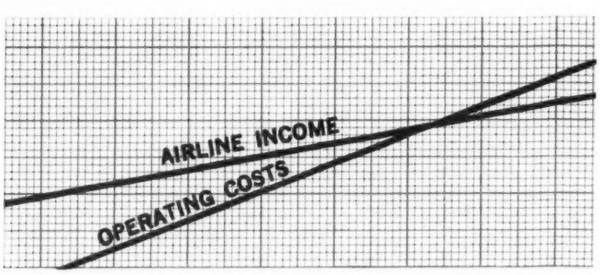
Today, airlines in all parts of the world face a unique dilemma. Traffic and gross revenue are growing rapidly. *But* costs of operation are growing even *more* rapidly, shrinking or even wiping out profit margins.

Airline directors, management, banking firms and government agencies are confronted with this problem at a time when airlines face monumental *new capital costs* in re-equipping for the turbine-age.

The Importance of Sound Aircraft Economics

Passenger-airplane economics involve two interacting groups of factors: (1) First costs, flight and maintenance costs, overhead. (2) The airplane's payload and revenue potential at pre-fixed rates.

This relationship establishes the relative profitability of any airplane.



However, analysis of an airplane's relative profitability is valid only when these economic factors are applied to the specialized "use and environment" in which it will operate.

Airline "uses and environments" divide into three basic patterns. The clearly defined "long haul" and "short haul" ... and the less clearly defined "medium haul".

"Short-to-medium hauls" generate 35% to 65% of all the world's air traffic. However, overhead and operating costs are relatively higher in this area because of shorter flights, comparatively more time spent on the ground *and* higher passenger unit overhead.

Yet profit or loss in "short-to-medium haul" operations determines over-all airline financial success!

LOCKHEED ELECTRA – The Only Realistic Answer to the Turbine-Age Need for Sound Economics in Short-to-Medium Haul Operations.

Specific Economic Design Objective:

SIZE

Not too big to operate profitably with few passengers on thinner traffic density routes...

But big enough to operate on high density routes with frequent schedules for maximum passenger appeal.

TURBINE POWER

Turbo-prop NOT Turbo-jet, to produce wide margins of superiority in operations requiring many stops, many take-offs and landings *which require:* (1) Wide choice of cruise altitude flexibility; (2) No new techniques in air traffic control, approach, holding or landing. (3) Sure stops on short or icy runways. (4) Quick acceleration for "go-arounds". (5) Shorter maneuver times. (6) Lower "holding" altitude and costs.

SPEED

Fastest cruise speed needed, considering short average times at lower cruise altitudes. Produces *shortest elapsed times* on "many-stop" schedules — with full all-weather operation.

SHORT-HAUL EFFICIENCY DESIGNED IN

Electra special abilities include:

—Ability to make many stops without en route refueling.

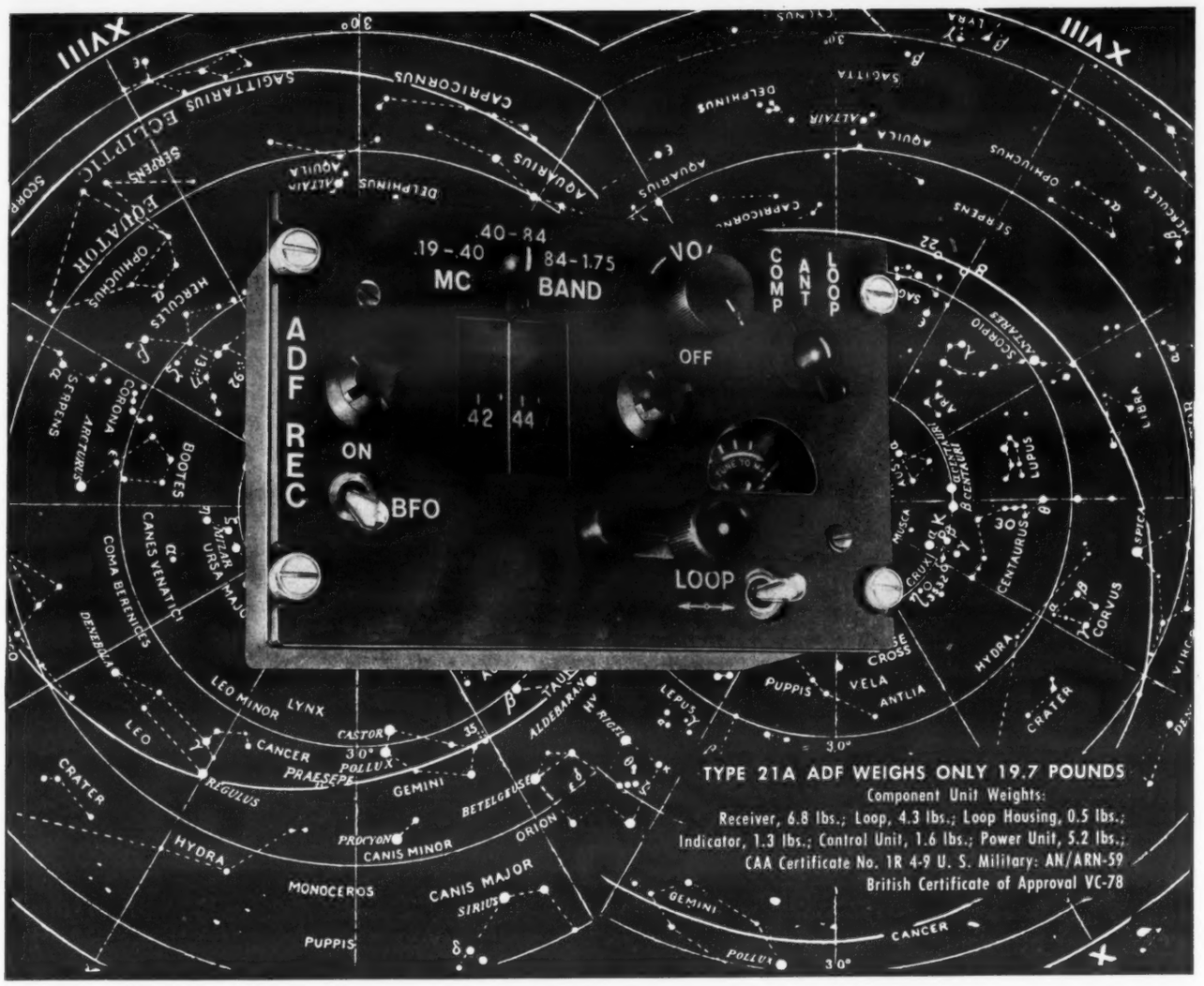
—Quick en route servicing for short stop times accomplished by: *"Packaged"*, separate electrical, hydraulic and air-conditioning centers. *"One point"* high speed refueling. *"Systematized"* simultaneous servicing and passenger loading. *"Broad Vision"* windshield. *"Carry on"* baggage facilities.

Electra functional design features were defined by the experience of American Airlines and Eastern Airlines, checked by the sponsorship of:

Aeronaves de Mexico · American Airlines · Ansett/ANA of Australia · Braniff Airways · Cathay-Pacific Airways · Eastern Air Lines · Garuda Indonesian Airways · KLM Royal Dutch Airlines · National Airlines · PSA—Pacific Southwest Airlines · Western Air Lines

THE PROPER TOOL FITTED TO THE JOB

LOCKHEED
AIRCRAFT CORPORATION
Burbank, California, U.S.A.



Modern Star

For World-Wide Aircraft Navigation

ARC's TYPE 21A AUTOMATIC DIRECTION FINDER

Because it can be tuned to some 60,000 transmitters, spread all over the world, the ADF is a widely used navigation aid. Important news about the ADF, however, is that ARC has engineered this basic instrument down to less than 20 pounds in weight, with a comparable saving of space. Now pilots enjoy the advantages of dual installations of this compact miniaturized equipment in tolerable weight and space requirements.

The ARC Type 21A ADF is built to today's more critical speed and environmental demands. It has hermetic sealing of vital components, such as the entire loop assembly. It covers all frequencies from 190 kc to 1750 kc . . . operates on only 2.8 amps at 27.5 volts dc input or equal power at 13.5 volts. A significant feature is the extremely low loop drag—only two inches outside the aircraft skin. Ask your dealer for detailed literature.

Dependable Airborne Electronic Equipment Since 1928

Aircraft Radio Corporation BOONTON, N. J.

30 YEARS OF ACHIEVEMENT 1928 ARC 1958 IN AIRBORNE ELECTRONICS

OMNI/ RECEIVERS • MINIATURIZED AUTOMATIC DIRECTION FINDERS • COURSE DIRECTORS • LF RECEIVERS AND LOOP DIRECTION FINDERS • UHF AND VHF RECEIVERS AND TRANSMITTERS (5 TO 360 CHANNELS) • INTERPHONE AMPLIFIERS • HIGH POWERED CABIN AUDIO AMPLIFIERS • 10-CHANNEL ISOLATION AMPLIFIERS • OMNIRANGE SIGNAL GENERATORS AND STANDARD COURSE CHECKERS • 900-2100 MC SIGNAL GENERATORS

Rockets, Missiles and Space Vehicles

● British missiles for Sweden?

The Swedish authorities are considering the purchase of a complete British ground-to-air missile training battery, and the final short list has now been narrowed down to the Bristol *Bloodhound* and the English Electric *Thunderbird*. According to a report filed by *Interavia's* Correspondent in Gothenburg some Swedish sources are reportedly very concerned about the high cost figure, in the neighbourhood of 100,000,000 Swedish crowns, and are opposed to the project. Other missiles, particularly those of French manufacture, are also believed to be under examination.

● WS-117L Pied Piper

Major General B. A. Schriever, Director of the U.S.A.F. Ballistic Missiles Division, told representatives of the Aircraft Industries Association of America in Washington that the WS-117L *Pied Piper* observation satellite, now under development by Lockheed, will have a weight of over 1,300 lb. Lieut. General Donald Putt, Deputy Chief of Staff for Development, has said that the U.S.A.F. will spend over $50,000,000 on this project during the current fiscal year and expects to spend over $100,000,000 during fiscal 1958/59. The complete weapons system including the necessary ground stations, equipment and facilities is scheduled for a first launch date in the near future, probably this year.

The *RAT* (*Rocket Assisted Torpedo*) surface-to-underwater anti-submarine weapon is launched from a platform which can be fitted to any 5-inch gun turret (below).

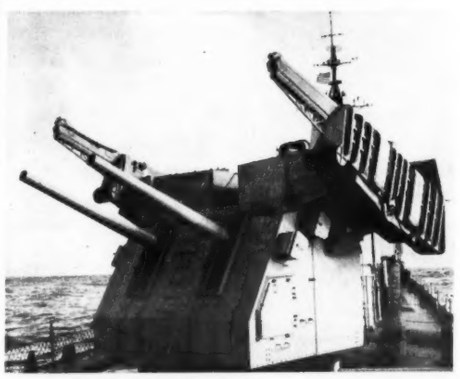
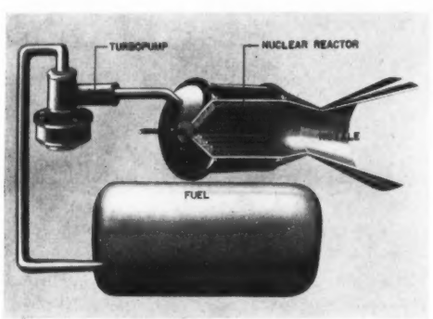


Diagram of the proposed North American nuclear power unit.



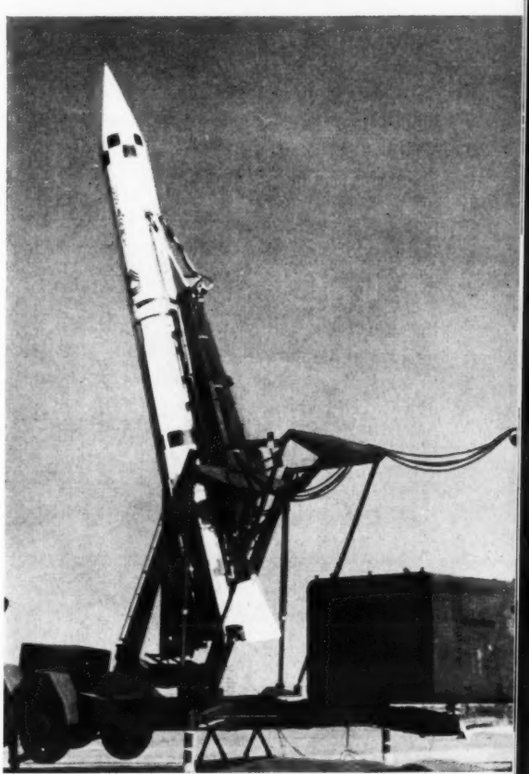
● New American anti-submarine weapon

The U.S. Navy has announced that a new rocket-launched anti-submarine missile has been developed and is scheduled to become operational with the fleet towards the end of 1958. Designated *RAT (Rocket Assisted Torpedo)*, the weapon is a cross between a ballistic missile and a torpedo, and is capable of searching out its target over considerable ranges with almost 100 percent kill certainty. The launching ramp can be installed on any standard 5-inch gun turret, current armament in United States cruisers and destroyers, and it will thus be possible to equip a major portion of the fleets with the new anti-submarine weapon within a comparatively short time. RAT utilizes the parent ship's submarine detection and tracking system, but has its own specially developed fire control system which is a modification and extension of the ship's existing system. The sequence of operation is thus: the parent ship detects and tracks the hostile vessel, and at the same time the RAT fire control system automatically computes and passes bearing, elevation and range command data to the launching platform; on launching the RAT is rocket-propelled into a ballistic trajectory towards the target; as the missile approaches the target area, the airframe separates and is discarded, and a first parachute opens; further parachutes are employed to stabilize the missile and to give it the proper water entry speed; beneath the surface the parachutes and nose cap are discarded, and the torpedo proper begins a search pattern; the acoustic homing device seeks out the target and the torpedo kills. The RAT is 16 ft. in length and weighs 450 lb.

Claimed to be the greatest advance in anti-submarine warfare since World War II, the new weapon is scheduled to become operational with the U.S. Navy by the end of 1958, and has been developed for the U.S. Navy Bureau of Ordnance by the Naval Ordnance Test Station, Pasadena and China Lake, Calif.; fire control and systems management by Librascope Inc., Glendale, Calif.; torpedo developed by Clevite Research Corp., Cleveland, Ohio; launcher by Puget Sound Naval Shipyard, Bremerton, Washington.

● Nuclear-powered rocket motor

The Rocketdyne Division of North American Aviation Inc. has recently been awarded a U.S.A.F. research and study contract for work on a nuclear-powered rocket motor which will permit a hundredfold increase in present day space vehicle payloads. Following the announcement of this contract North American released the drawing published herewith: an as yet unspecified working fluid would be converted in a nuclear reactor into ultra-high temperature gases whose lighter molecular weight would allow them to stream through rocket nozzles at enormous velocities, creating a propulsive thrust several times greater than that of current chemical rockets. The gases thus created would be free of the relatively heavy products of normal combustion. As in normal liquid-propellant rocket motors the propellant will probably be fed to the reactor oven by means of a turbopump.



Preparations for test launching the *Sergeant* short-range ballistic missile at the U.S. Army's White Sands, New Mexico proving ground. These first pictures of the *Sergeant* show the adjustable mobile launching cradle utilized for the solid-propellant rocket weapon. Further development of the *Sergeant* is currently being carried out by the California Institute of Technology's Jet Propulsion Laboratory in conjunction with the Sperry Gyroscope Company who will later be responsible for production of the weapon.

Aviation in the Low Countries

Report on a Tour of Holland and Belgium

by Interavia's Special Reporter, E. Baur

The Air Terminal and Headquarters of Sabena in Brussels. In the background the Tower of the Brussels City Hall—a landmark of the Belgian capital.

To discuss both Dutch and Belgian aircraft industries under a single heading could perhaps give rise to some misunderstanding. To the outside observer the industries and airlines of these two States may not appear to be working with a high degree of cooperation. Nevertheless the ways of life, industrial resources and spheres of political interests of the two Benelux nations are remarkably parallel. In the final analysis this is a direct result of a long historical association stemming back to the days when " the Low Countries " stretched from the Frisian Islands down to the Ardennes.

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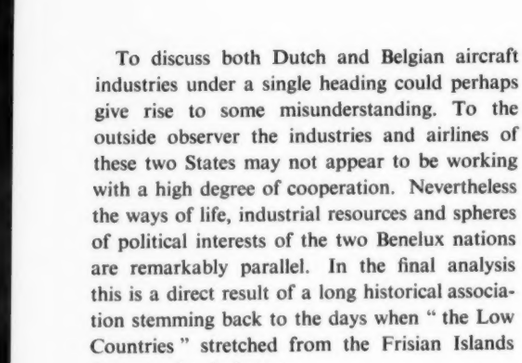
So far as the aircraft industry is concerned it is clear that Holland can call on a long tradition



On June 1st this year part of the new terminal buildings at Brussels-Melsbroek—shown here in model form—will be opened for traffic.

going back to those heroic days when aircraft were built *(sic)* of wood, wire and fabric. On the other hand, Belgium's aircraft industry before the 1920s was, for all practical purposes, non-existent. But a visitor to the contemporary Fokker plants or, for example, to the Belgian plants of SABCA and FN is rapidly convinced that both Belgium and Holland have made tremendous progress since the end of the war; the aircraft manufacturing plants of both countries have, so to speak, since 1945, been built up again from nothing and today take their places amongst the most modern production facilities in continental Europe.

The general public usually labels Holland as an agricultural country, and Belgium as industrial. However, if the visitor wanders through the apparently unending industrial areas of Amsterdam, Eindhoven, Hilversum or Hengelo, or has the opportunity of seeing the Philips works where over 50,000 people are employed, then Dutch tulips, ornamental stoves and windmills are very quickly seen in their proper perspective.

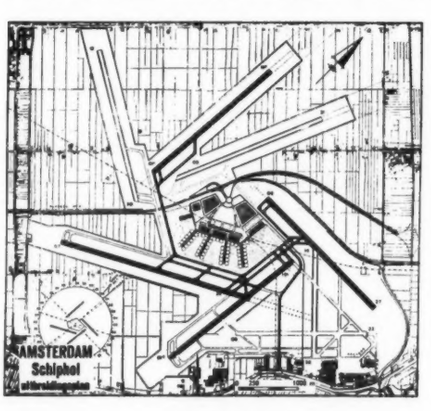
Schiphol and Melsbroek, KLM and Sabena . . . a design for the jet age

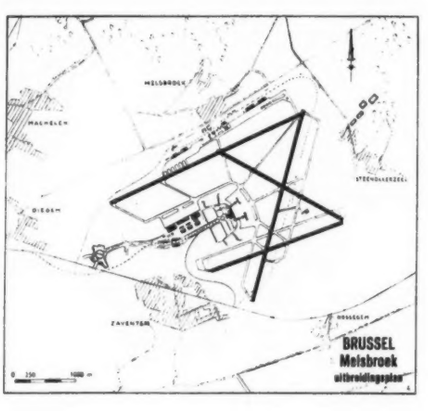
Both Holland and Belgium are making strenuous efforts to ensure that the International Airports at Amsterdam-Schiphol and Brussels-Melsbroek are equipped to cope with the civilian jet traffic which is promised for the future. At Schiphol for instance, alongside extensive administrative and technical building construction, the main runways have not only been lengthened, but have also been thickened to take 200-300 ton aircraft. For their part, KLM's technical services are also energetically engaged in a wide modernization programme. To mention only a few outstanding examples, the construction of a new workshop for the servicing and maintenance of jet engines is well advanced; work is already in hand on additional test stands for jet engines of the 15,000-20,000 lb. thrust class. In the meantime some of the existing workshops have been adapted to cope with turboprops in order that servicing of the Rolls-Royce *Dart* engine, in KLM's *Viscounts*, and Allison 501 units powering the Lockheed *Electras* now on order, will present no difficulties.

KLM Technical Services experts hold the opinion that, in the long run, it will be essential to provide new hangars for the Lockheed *Electras* and Douglas DC-8s which will come into service in 1959/1960. However, for the time being it is considered that a part of the existing, almost new technical buildings will be able to cope with the first giants of the coming turbine fleet.

In general it is clear that responsible Schiphol and KLM officials are approaching the transition to turbine aircraft with every confidence, and are basing their plans on the fact that this transition will not occur overnight, but will be a staged development.

Preparing for the jet age: Plans of Amsterdam-Schiphol and Brussels-Melsbroek Airports showing the layout of runways and terminal buildings on completion of the present work.





The Brussels World Fair will have a decisive influence on Sabena's 1958 traffic year. The Belgian flag-carrier's General Manager Willem Deswarte has said that Sabena will be represented in both the Belgian Transport Pavilion and the Belgian Congo's "Transport and Power" Pavilion; one exhibit will be a 40 ft. mock-up of the fuselage of a Boeing 707, on order by Sabena. The airline will also establish a heliport in the fairground, complete with customs and police authorities, and from which regular services will be operated to Melsbroek. For 1958 Sabena anticipates a 31 percent increase in capacity tonne-kilometres compared with 1957; the last four of the ten Douglas DC-7Cs on order will enter service and, to increase the frequency of the New York service to three flights daily, Sabena has chartered two Lockheed L-1049H *Super Constellations* from Seaboard & Western complete with crews for the period of the Fair.

On June 1st this year a part of the new terminal buildings at Brussels-Melsbroek will be opened for traffic. During the period of the Brussels Fair additional new radar equipment will also be brought into operation at Melsbroek; this is a joint undertaking of several French firms and will feature many interesting new developments.

Friendship — Freightship — Troopship

The Fokker plant at Schiphol-South near Amsterdam is the scene of lively activity with production of the F.27 *Friendship* short and medium-haul passenger turboprop aircraft well in hand. The company has recently put through a reorganization of both administrative and production processes which will result in boosting the monthly output from two to six aircraft. The first production model F.27, on order for Air Lingus, will be ready for flight testing in April this year, and delivery is scheduled for October 1958.

Parallel with this production Fokker is working on the development of several special versions of the F.27. As well as a *Freightship* version, a VIP de luxe executive version for 10-16 passengers is planned, and this aircraft will be the last word in modern comfort with a conference section, bar and bridge corner. On a more mundane level the *Troopship* is planned as a military transport to accommodate either 42 paratroops or 54 fully equipped infantrymen.

A large proportion of the production capacity at Fokker's facilities has been devoted to the licence manufacture of the *Hunter*, but now that this programme is being phased out, almost the entire facilities can be devoted to *Friendship* production.

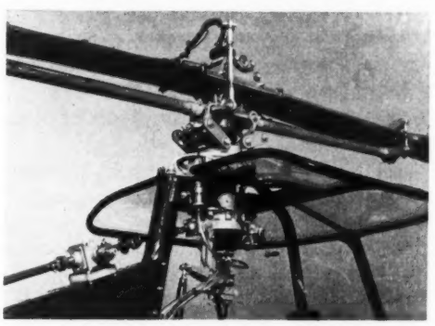
Mention must also be made of the close cooperation between Fokker (and Aviolanda) and the Belgian firms SABCA and Fairey in licence production of the *Hunter* for the Dutch and Belgian Air Forces. The Belgian undertaking Fabrique Nationale d'Armes de Guerre (FN) is manufacturing the *Hunter's* powerplants for both Belgian and Dutch use.

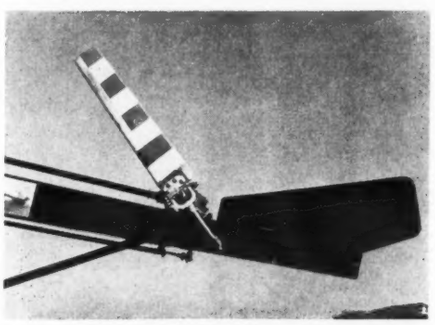
Fokker is also engaged in the production under licence of Bristol jettisonable plastic auxiliary fuel tanks for the Dutch Air Force; other work includes manufacture of the antenna reflectors and ancillary equipment for radar designed by Hollandse Signaalapparaten, Hengelo, and by Philips, and components (especially rotor blades) for the H-3 *Kolibrie* light helicopter now in production by Nederlandse Helicopter Industrie in Rotterdam.

Remarkable new Dutch helicopter

The relatively modest workshops and offices of Nederlandse Helicopter Industrie located on Rotterdam Airport are hardly indicative of the growing activities of this dynamic young firm. Under the personal supervision of the Manager, Ing. G. F. Verhage, and his Chief Designer, Ing. J. Meijer-Drees, it has been possible to develop the H-1 and H-2 helicopter prototypes in a very short space of time into the H-3 *Kolibrie* production model, and to start building a pre-production batch. On March 3rd, 1958, the H-3, powered by two Kromhout ramjet engines, received its type certificate, and is thus believed to be the first ramjet helicopter to receive civil type certification.

The H-3 *Kolibrie* lightweight helicopter with two Kromhout ramjets. The detail shows the rotor head and the single-bladed tail rotor. Bottom: The H-3 helicopter is in production at the Nederlandse Helicopter Industrie's at present rather modest workshops.





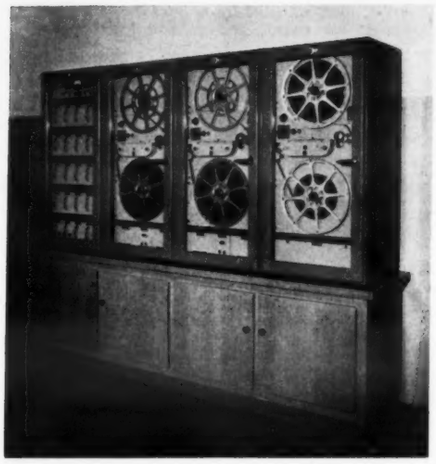
Manager Verhage told *Interavia* that ten *Kolibries* are under construction at the present time and that firm orders for six had been received from Dutch customers. More recently an Israeli order for three H-3s has been announced; in view of the helicopter's relatively low initial purchase price and operating costs, no difficulties are anticipated in acquiring further orders. The price of the *Kolibrie* is some 35 percent lower than conventional types and is comparable to that for fixed-wing agricultural types of equivalent capacity.

The performance of the H-3 is most impressive and full credit must be given to the unchallenged mastery of N.H.I.'s Chief Test Pilot van der Hart. The design provides extraordinary stability, and transition to autorotation is achieved very rapidly; this was effectively demonstrated by van der Hart at an altitude of some 150 ft. despite heavy rain and a windstorm. Operation with one dead ramjet is completely feasible, and re-firing of an extinguished unit follows without difficulty.

Holland's aviation electronics

N.V. Hollandse Signaalapparaten, Hengelo, is well known to *Interavia* readers, the company's SATCO System (Signaal Automatic Air Traffic Control) having been discussed in detail in *Interavia* No. 3, 1958, and No. 6, 1957. Hollandse Signaal is also well known as a major manufacturer of fire control apparatus and remote control systems; fire control systems from Hengelo have been supplied to the armies, navies and air forces of many countries. Quite recently the company, in which the Philips concern has a majority interest, has announced the receipt of a contract for the supply of radar and fire control equipment for the West German Navy.

Following a short visit to the Nationaal Luchtvaart Laboratorium's (NNL) research laboratories and wind tunnel facilities in Amsterdam, *Interavia's* reporter went on to Hilversum and Eindhoven, two towns on which the giant Philips enterprise has made its mark. Airport and airborne radar equipment, communications systems and magnetic tape recorders, airport lighting systems, factory and laboratory equipment—these headings give only a brief insight into the manifold activities of the international firm of Philips. Details of some of the company's equipment under current production are given in the feature "Telecommunications and Electronics" in this issue. To quote only one example the Philips production programme for airport radar systems currently includes: the SGR 200 (25 cm surveillance radar, range 125-175 nautical miles, with a Fokker-built 52 ft. × 16 ft. antenna reflector); the SGR 500 (10 cm approach radar); the SGR 250 or 8 GR 250 (8 mm airfield surface movement indicator); and quite recently in production, a new version of the SGR 500 modified for target tracking.



Numerous Air Traffic Control Centres throughout the world make use of Philips multi-channel magnetic tape recorders for the continuous recording of radio traffic, arrival and departure instructions and local airport announcements. The picture shows a triple-bank recording equipment each handling fifteen tracks on a 16 mm tape; tape speed is 4.75 cm per second, adequate for handling normal conversation in the 300 to 3,000 cycles audio frequency range. Track 15 normally carries a time recording taken for example from the telephone network. The equipment is contained in four units each 21.5 in. wide, 46 in. high and 18 in. deep. The left-hand unit contains the amplifier, oscillators and control unit, while the remaining units contain the motors, relays and power supply. Although in theory two tape units are sufficient to ensure uninterrupted operation a third unit is proposed to achieve additional operational reliability.

Amsterdam-Schiphol Airport as pictured on the screen of a Philips Type 8GR 250 ASMI (Airfield Surface Movement Indication) radar.

Aircraft production in Belgium

The most important of Belgium's aircraft manufacturers is the firm SABCA (S.A. Belge de Constructions Aéronautiques) mentioned earlier, with plants at Haren-Brussels, and Gosselies near Charleroi. For the moment mainly occupied with the production of Hawker *Hunters* under licence (particularly wings and undercarriages), SABCA is very active in promoting the conception of European cooperation: as sub-contractor to France's Sud-Aviation, SABCA is producing components for the SO.4050 *Vautour* twin-jet combat aircraft, and for the SE.210 *Caravelle* jet liner. Mention must also be made of the agreement signed some time back between SABCA and Fokker, under which the former is sharing in *Friendship* production. SABCA, mainly the Gosselies plant, is also working on IRAN (inspect and repair as necessary) contracts for U.S.A.F. units stationed in Europe, and is overhauling T-33 jet trainers and *Beaver* light transports.

Finally the work being done in SABCA's special departments for undercarriages, hydraulic and fuel systems also merits attention.

On the opposite side of the airfield at Gosselies are the workshops of Avions Fairey S.A., founded in 1931 and a subsidiary of Britain's Fairey Aviation Company. The company made its name well before the war with a whole range of sports and training aircraft—*Tipsy Belfair*, *Tipsy S*, etc.—all designed by E. O. Tips, Manager of Avions Fairey.

Although the Belgian Fairey plant is now also engaged in *Hunter* production (particularly fuselages and final assembly) and has IRAN contracts for the U.S.A.F.'s F-84Fs, a new model recently came out of E. O. Tips' design office—the Type 66 *Tipsy Nipper* ultra-light single-seat sports aircraft, also available in a home construction kit. Powered by a Volkswagen engine, the *Nipper* is designed for a cruising speed of approximately 56 knots.

With the *Nipper*, Fairey of Gosselies has returned to an old tradition, the manufacture of sports aircraft, and it will be no surprise if E. O. Tips soon comes forward with an announcement of orders for other sports and touring aircraft.

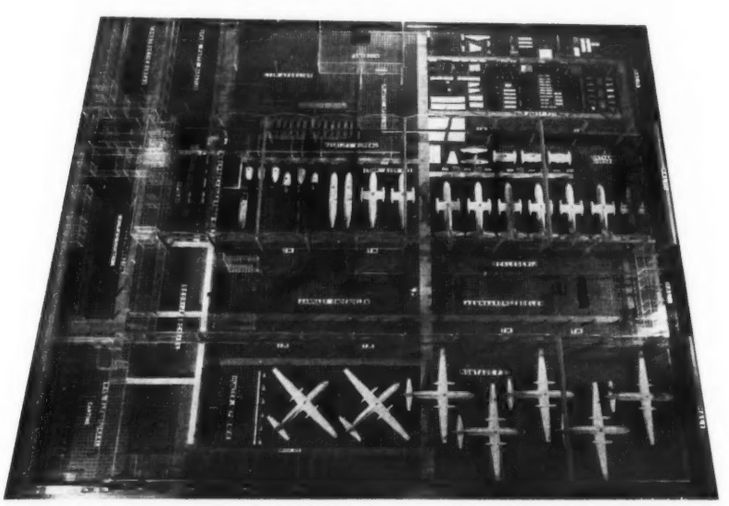
One additional note: much of the equipment such as test-beds etc. in the workshops and laboratories of both SABCA and Fairey carries the "ACEC" label, the next company to be visited.

Belgium's electronics industry

The Belgian firm ACEC (Ateliers de Constructions Electriques de Charleroi) has a current payroll of 14,000 employees and the company's activities, which cover almost the entire field of electrical and electronic equipment, are spread over five plants and two subsidiary concerns in Belgium. The company also controls the activities of other plants in Portugal, Ireland, France, Argentina and Brazil, and has an interest in a new undertaking recently established in the Belgian Congo in association with other Belgian firms.

Space does not permit a full catalogue of the company's production, but it is sufficient to mention that eight Divisions cover such items as: fractional-hp electric motors up to hydrogen-cooled 325,000 kVA turbo-generators; 5 kVA to 150,000 kVA transformers; capacitators; all types of flex and cable up to 1,000 pair; radios and radar; and since 1957, nuclear reactors and radiation measuring equipment. A random example is the company's magnetic tape recorder, various versions of which have been supplied to Regie des Voies Aériennes, the Belgian Air Force, the French and Spanish civil aviation authorities, and exported in considerable quantities to South America.

The final representative of the electronic industry visited by *Interavia's* Special Reporter was MBLE (Manufacture Belge de Lampes et de Matériel Electronique S.A.) whose plants are located at Anderlecht, Evere and Haren, and in the Belgian Congo. It is again difficult to describe in a few words the varied and wide-ranging production programme undertaken by this company. Among other interests MBLE is well known on an international basis for its activities in the field of electronic tubes. The company's display at the forthcoming Brussels World Fair will be housed in a giant model of a valve as a symbol of its tremendous progress in the electronics field.



Friendship production. Fokker has recently introduced organizational and production changes which will enable the output of F.27 *Friendships* to be increased from two to six aircraft per month.

Research and production activity at the Philips concern covers every branch of radio and radar equipment. This post-war Philips plant in Hilversum is mainly concerned with the production of radio and radar equipment for aviation.

A summary cataloguing of MBLE's production shows the following items: HF, VHF and UHF transmitter/receivers; telemetering and remote control equipment; for military requirements, an equipment for continuous recording of meteorological data and an airfield status calculator (availability of runways, etc.); fire control equipment for anti-aircraft batteries.

A short visit to the laboratories and production lines of Photo-Produits Gevaert S.A. in Antwerp served to underline once again the important role which both photography and film has to play in industrial processes. Doctor Lauwers, Chief of the Research Department, and R. de Groote, Head of Public Relations, stressed the increasing multiplicity of tasks for photography in the recording of laboratory results, material testing, etc. The photographic material produced by Gevaert is of special interest to the aviation world in the tasks of survey and reconnaissance.

Aircraft engine production for Benelux . . .

The last visit in this tour of the Benelux industries was to the Fabrique Nationale d'Armes de Guerre (FN), whose main plants are at Herstal-lez-Liège, Bruges and Zutendael. Over 12,000 employees are engaged in the various divisions producing Weapons and Ammunition, Aircraft Engines, Trucks for military and civil purposes, Trolleybuses and Motor Cycles. The total facility includes some 9,000 machine tools, the majority of which are very modern.

In a personal interview, Manager A. Regout gave *Interavia* more detailed information on the activities of the Engine Division, where the Rolls-Royce *Derwent* has been produced under a licence agreement dating back to 1949. A production series of 1,000 units were built to meet the requirements of the Belgian and Dutch Air Forces for the *Meteor* fighter; the first production model of the *Derwent* went on to the test bed in August 1950, and the series was successfully completed by the end of 1954.

Following this, FN's Engine Division was turned over to the production of axial-compressor jet turbines and commenced manufacturing the Rolls-Royce *Avon* RA.7 and RA.14 under licence; these power units were for equipping *Hunters* for the Belgian and Dutch Air Forces. Alongside the jet engine production programme FN inaugurated a servicing and overhaul section, and a section for the production and supply of spare parts; the works is equipped with its own test beds.

Belgium's Fabrique Nationale d'Armes de Guerre (FN) operates three plants at Herstal-lez-Liège (pictured), Bruges and Zutendael; the aircraft engine division is currently producing *Avon* RA.7 and RA.14 axial compressor jet turbines under Rolls-Royce licence. The *Avon* units produced by FN are being installed in *Hunters* manufactured in Belgium and Holland.

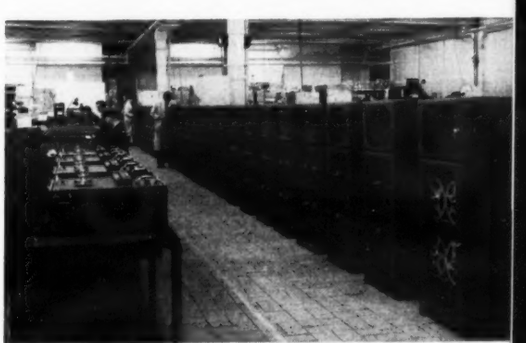
When production of the *Hunter* in Belgium and Holland is finished FN will also close down on the production of the *Avon* power units, and the Division's activities will be largely confined to overhauls and the production of spares.

The plant at Herstal, for example, offers an outstanding production potential for the manufacture of modern jet turbine engines; and this potential could be considerably increased without any serious difficulties and would be very suitable for both military and civil production.

*

In summing up it can be seen that although the much discussed European cooperation within the aircraft industry has still not yet generally reached the desired level, the Benelux countries have in the meantime demonstrated the advantages to be derived. But even in Belgium and Holland it was once again underlined how essential this cooperation is; it was clear that the production capacity of certain plants was not fully utilized due to a shortage of orders, while other undertakings are being compelled to offer long delivery dates because of the overloading of the available plant. This situation is even more regrettable since, with the modern machine tools and technical skill available, this comparatively young industry could claim a bigger share of the world's markets.

The ultra-light Type 66 *Tipsy Nipper* single-seat sports aircraft produced by Avions Fairey S.A. in Gosselies. Powered by a Volkswagen engine the *Nipper* has a cruising speed of about 56 knots, with a take-off distance of 440 ft. and a landing distance of 290 ft.; span 19.7 ft., wing area 80.7 sq. ft., maximum gross weight 660 lb.

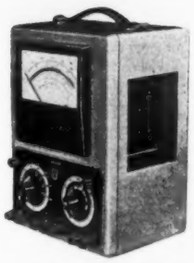


Production in ACEC's (Atelier de Constructions Electriques de Charleroi) eight main divisions includes magnetic tape recorders as supplied to Belgium's Régie des Voies Aériennes, the Belgian Air Force, French and Spanish civil aviation authorities. The picture shows a section of the production line for the Type 481 GT recorder and its ancillary play-back apparatus Type 482 GT pictured left.

Telecommunications and Electronics

● **Philips measuring instruments**

GM 5650 small HF oscillograph, with DC amplifier and triggered time base, especially designed for pulse techniques and high and low frequency work. For the control of switching devices and equipment used in industrial electronics and telecommunications, particularly TV services.

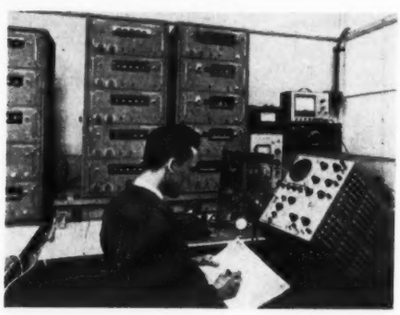


GM 6008 universal electronic tube measuring instrument. A diode voltmeter with cathode follower for measuring DC and AC voltage and current, resistance and capacitance:

- Direct voltage: 20mV . . . 300V, 0 . . . 1kV, and with special probe 0 . . . 30kV.
- Alternating voltage: 100mV . . . 300V.
- Direct current: 0.03 μA . . . 1A.
- Alternating current: 0.1 μA . . . 10mA (20c/s-⩾100kc/s) and 10 μA . . . 1A (20c/s-⩾1kc/s) with a voltage drop less than 1V.
- Resistance: 1 ohm . . . 1,000 Megohms.
- Capacitance: 30 pF . . . 3 μF.

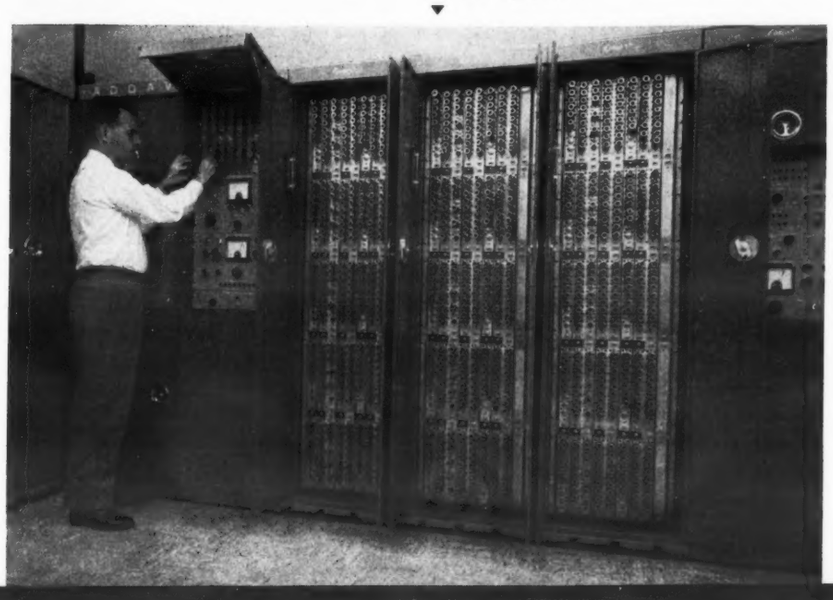
GM 4580/02 electronic switch is supplementary equipment for single beam oscilloscopes, for visual presentation of two electrical or physical phenomena. The instrument comprises two similar and separate amplifiers, a switching device, and a supply unit. The voltages to be studied are fed to the amplifiers, and the parallel outputs are passed to the vertical deflection plates of the CRT. A multi-vibrator generates rectangular voltages which alternatively open and close the two amplifiers with adjustable frequency. The amplifier input signals are fed alternatively to the deflection plates of the CRT.

GM 4144 universal measuring bridge with a cathode ray indicator and built-in calibration device, designed on the Wheatstone principle. For simple measurement of resistors, capacitors, electrolytic condensers and power factors, and comparative measurement of self-induction.



● **Electronic pulse counter** undergoing final inspection in the nuclear research laboratories at MBLE (Manufacture Belge de Lampes et de Matériel Electronique S.A.).

● **Space Technology Laboratories,** a division of Ramo-Wooldridge Corp., are utilizing the "Addaverter", a translating device for linking analogue and digital computers. The instrument contains over 2,000 vacuum tubes, of which approx. half are located in the 15 digital-to-analogue converters (DAC) shown here in the three cabinets to the right of the control equipment. A similar number of analogue-to-digital converters (ADC) are located on the left of the control equipment.



● **Electronic instruments for Russian industry**

The "VPRR" computer is utilized to determine optimum operation of lathes in consideration of machine data, materials and tool characteristics.

Russian analogue computers, similar to that pictured here, will reportedly be shown at the Brussels World Fair.

The T80-102 electronic digital tabulator for the evaluation of graphic recordings, numerical data and statistics. Data are fed by means of punched cards and the results are printed on paper tape.

This electronic instrument is used for the analysis of graphic curves in the fields of mechanics, hydro- and aerodynamics, optics and acoustics.

A Combination Powerplant for High-Performance Aircraft

by Jacques Dupin, Director of Research, Nord-Aviation, Paris

The author, a graduate of the *Ecole Nationale Supérieure de l'Aéronautique*, Paris, has been active in the aircraft industry since 1934. Before the war he held technical posts with Potez, Latécoère and Breguet, and in 1946 joined the State-owned Arsenal de l'Aéronautique, an organization later transformed into SFECMAS. When the latter company was merged with SNCA du Nord (today Nord-Aviation) in 1954, Jacques Dupin became responsible for the research division engaged on the development of high-speed aircraft and ramjet powerplants. Editors.

The recently announced performance of the Nord-Aviation *Griffon 02* research aircraft *(fig. 1)* has drawn world-wide attention to this aircraft and to the combination turbojet/ramjet powerplant with which it is equipped.

The idea of combining a turbojet with a ramjet is not new. It may even be said that this is an obvious step, since the two forms of propulsion are naturally complementary; the ramjet delivers no thrust at all at low speeds, while the turbojet's thrust (and efficiency) falls off above a Mach number at which the ramjet's is still increasing.

Nevertheless, it is not easy to combine the two categories of power unit in a rational manner. The first ramjet-powered aircraft were built by *René Leduc*, who began work in this field before the war, leading up to the Leduc 016 and 021. Leduc's latest model, the 022 now undergoing tests, and the Nord-Aviation *Griffon* were the first two aircraft with this type of mixed propulsion and have revealed that the combined turbojet/ramjet powerplant meets all the requirements of very high performance aircraft capable of taking off under their own power and of cruising at moderate speeds. The *Griffon's* recent flights have proved that the claims for this type of powerplant are justified.

The Griffon's powerplant

In the *Griffon* the turbojet portion of the powerplant, a SNECMA Atar 101-E3 of 7,700 lb. static thrust, is mounted along the axis of the air intake duct to the ramjet (see box), the two air flows being separated by careful internal aerodynamic design. Similarly, the relative position of the jet pipes for the two engines has been carefully planned to cut unfavourable interaction to the minimum.

Undesirable interaction between the turbojet gas flow and that of the ramjet can be of two kinds. On the one hand, during take-off and at low speeds the turbojet exhaust acts as a suction pump and produces a marked negative pressure in the diffusor and combustion chamber of the ramjet, not yet ignited. The result is loss in thrust for the turbojet. On the other hand, when the ramjet is ignited, the mixing of the two jets, each with a different kinetic energy, can entail losses due to viscosity.

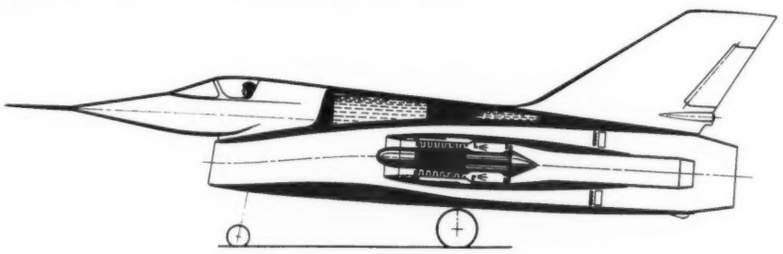
However, by judicious design, the ramjet combustion chamber can be given a good convergent-divergent aerodynamic configuration, as the turbojet exhaust flow widens towards the rear. Hence, under certain conditions, the efficiency of the combination powerplant may be higher than that of each of the two engines taken separately.

Moreover, losses during take-off have been reduced to a level below those of a conventional aircraft powered by the same turbojet with an air intake designed for supersonic speeds. Thus, despite the high drag offered by the cold ramjet, the *Griffon* has a take-off performance at least as good as that of a conventional aircraft with the same thrust/weight ratio.

Another problem to which a great deal of study was given is the necessity to ensure that possible irregularities in the ramjet's functioning, including cut-outs, do not adversely affect the turbojet's operation.

This problem has been satisfactorily solved in the *Griffon*, thanks in part to the good qualities of the Atar jet. On the one hand the cyclic variations in pressure linked with the combustion process in the ramjet have been kept to a very low level, and on the other the most violent disturbances which it has been possible to create

Longitudinal Section and Technical Data for Griffon 02



Length	45 ft. 9½ ins.	Gross weight	14,500 lb.
Span	26 ft. 6¾ ins.	Low-pressure tyres	
Wing area	344 sq.ft.	Take-off distance	3,280 ft.
Sweep	60°	Landing distance	1,970 ft.

Control surfaces: Elevators and ailerons combined to form elevons at the trailing edge of the delta wing; triangular tailplane attached to forward portion of fuselage.

Powerplant: Combination powerplant in fuselage, consisting of:

— SNECMA Atar 101 E-3 turbojet (production model) of 7,700 lb. static thrust.

— Nord-Aviation ramjet of annular section, with fuel system by the same company; the fuel pumps are driven by the turbojet via a mechanical relay and have a delivery of 8,800 Imp.gals./hr.

— A regulation system consisting of a fuel flow regulator and a mixture calculator with electronic limit switch.

Both the turbojet and the ramjet have a common fuel circuit (kerosene), except that the reserve fuel can be fed only to the turbojet to ensure safe return with ramjet extinguished.

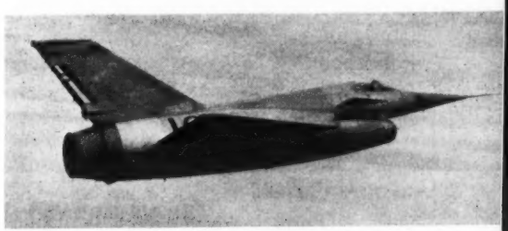
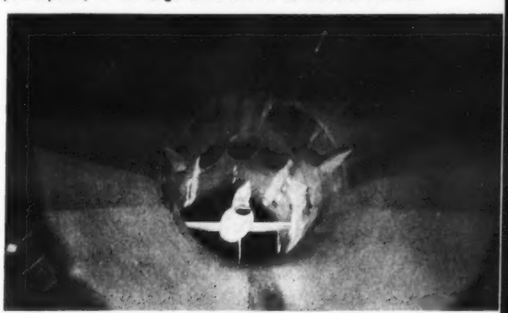


Fig. 1: The Nord *Griffon* research aircraft, which recently attained speeds of Mach 1.85 and a rate of climb approaching 20,000 ft./min.

Fig. 2: Full-size model of the *Griffon* fuselage, complete with powerplant, in the large wind tunnel at Modane-Avrieux.



in the combustion process during tests have been found to have no effect on the turbojet's speed and temperature. It should also be noted that it has not been necessary to modify the turbojet's regulation system, which is entirely separate from the ramjet's system.

The same principle of economy has been applied to other parts of the powerplant, all of which are extremely simple in design. The multiple flame holders are of U-shaped pattern, and the some 150 injectors have been designed, after careful study, to operate at a maximum pressure of 210 p.s.i. This enables simple gear pumps, driven by the turbojet via a mechanical relay, to be used for fuel feed. Their delivery rate can attain 8,800 Imp. gals. per hour, for a shaft power consumption of 40 h.p. A hydraulically operated flow control enables the quantity of fuel fed to the ramjet to be regulated to suit flight conditions (Mach number and altitude) and the position of the pilot's gas lever.

In initiating regulation action, the pilot is aided by an automatic mixture indicator which shows the fuel richness in the air flow to the ramjet in relation to the stoichiometric mixture. Coupled with this calculator is an electronic mixture limiter which controls regulation in such a way as to maintain the mixture between the rich and weak limits required for correct combustion at the altitude in question.

The ramjet can be ignited within a wide speed and altitude range. This is done by first igniting a number of pilot flames, whereupon the aircraft pilot need merely push a button to ignite the ramjet; all successive processes then take place automatically. The ramjet's thrust is felt immediately, but not brutally, recalling the sensation experienced when a good afterburner comes into operation.

Development and performance

One of the main difficulties which the designer encounters in developing a ramjet with the dimensions of the *Griffon's* power unit is how to undertake initial tests. The *Griffon's* combined turbojet/ramjet is, as far as any accurate comparison can be made, equivalent to a turbojet plus reheat with a static thrust of at least 44,000 lb.–but a turbojet for which no test bed is available where it can even approach its full power. Moreover the complete powerplant is so integrated into the airframe that it cannot be treated separately.

The only answer, therefore, was to make as many partial tests as possible and cut down to the minimum the problems which could be solved only in flight. For this purpose a preliminary prototype, the *Griffon 01*, was first built. This was identical externally with the mixed-propulsion aircraft, but was powered by an Atar 101 F turbojet with reheat. This aircraft, which first flew on September 20th, 1955 and made a total of 156 flights, enabled all aspects of the airframe to be tested up to very high Mach numbers, so that practically no airframe problems remained when the mixed-propulsion prototype began its flying.

At the same time a model was made of a combined turbojet/ramjet, around the small

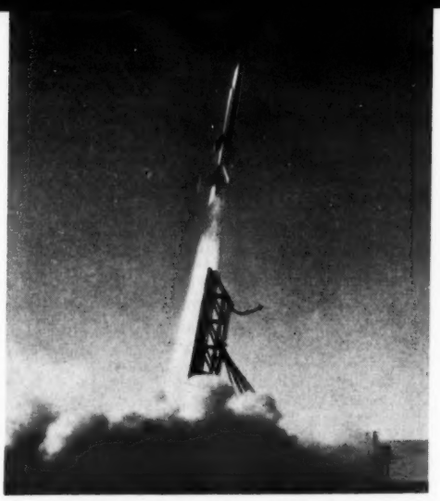


Fig. 3: Launching of a ramjet-powered ST 450 test vehicle with solid-propellant booster.

Turboméca *Palas* jet. This model was tested on Nord-Aviation's combustion benches and in the large wind tunnel at Modane, and provided valuable information regarding the "coupling" of the two engines. Finally, a full-size mockup of the *Griffon* fuselage was also tested in the same wind tunnel *(fig. 2)* up to Mach 0.65, with its powerplant in operation.

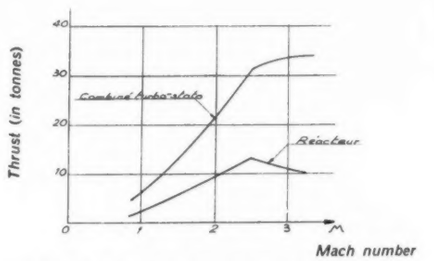


Fig. 4: Thrusts at 36,000 ft. for a reheat turbojet (*Réacteur*) of 17,600 lb. sea level static thrust and for the same turbojet combined with a ramjet (*Combiné turbo-stato*), plotted against Mach number.

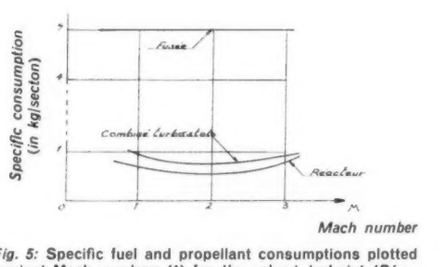


Fig. 5: Specific fuel and propellant consumptions plotted against Mach number; (1) for the reheat turbojet (*Réacteur*); (2) for the turbojet/ramjet (*Combiné turbo-stato*); (3) for the rocket (*Fusée*).

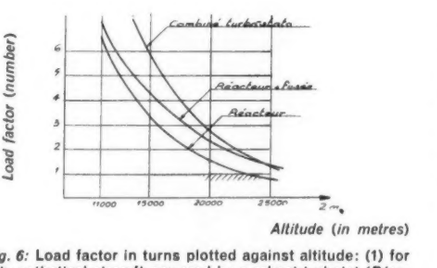


Fig. 6: Load factor in turns plotted against altitude: (1) for a hypothetical aircraft powered by a reheat turbojet (*Réacteur*; (2) for an aircraft with mixed propulsion (reheat turbojet plus liquid-propellant rocket of 3,300 lb. thrust; *Réacteur + Fusée*); (3) for an aircraft with combination powerplant (*Combiné turbo-stato*).

This very low Mach number obviously did not enable even a rough estimate to be made of the powerplant's performance, but it did permit the ignition sequence for the ramjet to be perfected under realistic conditions. It also provided an opportunity of checking the validity of what we had learned from the *Palas* model and of ascertaining the powerplant's behaviour during take-off and in flight without the ramjet.

Other preliminary work included partial bench tests, often very complicated, of equipment components, and launching tests of ST 450 missiles *(fig. 3)* which had been specially designed to prepare the way for the *Griffon's* flight programme. These missiles were accelerated to Mach 0.85 with the aid of a solid-propellant rocket and then propelled solely by their ramjet. They revealed as early as 1954 that a suitably designed ramjet raises no special problems in the transonic range.

Behaviour in the transonic range is a particularly critical problem in an aircraft with mixed propulsion. Since the ramjet's thrust varies roughly in proportion to the square of the aircraft's speed, provided the shock wave does not enter the diffusor, the lowest excess thrust is recorded in the transonic range. This means that an aircraft which is fundamentally capable of flying at Mach 2 or above may, if even relatively small errors are made in evaluating its thrust/drag behaviour, prove unable to exceed the speed of sound without resorting to a more or less steep dive.

The *Griffon 02*, however, proved to have no need of such artifices. After a first flight on January 23rd, 1957 with ramjet cold, it pierced the sound barrier in a high-speed climb for the first time, using its ramjet, on May 17th, 1957.

Tests then continued according to programme without serious incidents. Although not all the results obtained may be divulged, it can be said that Mach 1.85 was reached in the stratosphere, with a rate of climb approaching 20,000 ft./min. This performance is still well below the capabilities of both the airframe and the powerplant and suggests a promising future for the turbojet/ramjet combination.

The turbojet/ramjet's development potential

It is difficult to discuss the qualities of a powerplant of this category without comparing it with other methods of propulsion in its class, such as the reheat turbojet and the turbojet/rocket combination.

Incidentally, there is no reason why, when certain minor technical problems have been solved, the turbojet in the combined powerplant should not be equipped with an afterburner. This solution was not initially envisaged in the *Griffon* so as not to complicate the design unnecessarily. In any case the turbojet/ramjet combination will always be a relatively simple and economical method of increasing at least threefold the thrust of an existing jet engine in the supersonic range.

The curves in *fig. 4* illustrate this point. It can also be said that the turbojet/ramjet is superior to the turbojet/rocket combination. *Fig. 5* gives specific fuel and propellant consumption for three propulsion systems, plotted against Mach

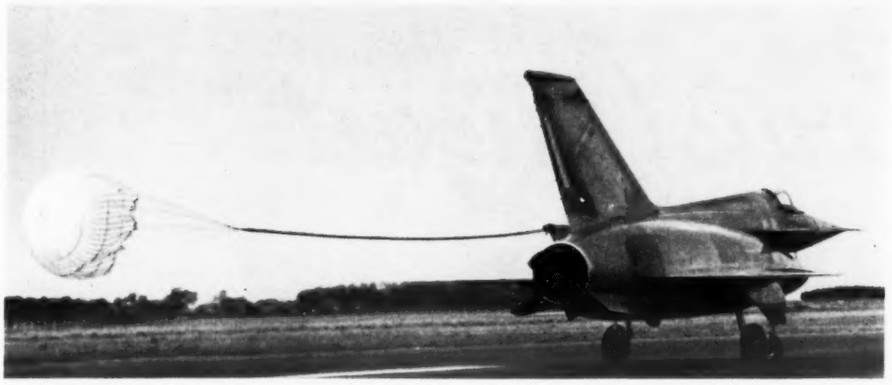


Fig. 7: The *Griffon 02* landing with the aid of a brake parachute.

number. It will be seen that the turbojet/ramjet has a relatively low fuel consumption.

To arrive at a completely objective assessment, however, allowance should also be made for the extra weight of the ramjet and its accessories, compared with the rocket motor, and for the extra consumption needed to overcome the high drag of the cold ramjet. But even with these corrections, we believe that an aircraft powered by the turbojet/ramjet combination will be lighter, for given performance, than one using a turbojet-plus-rocket powerplant, particularly where long periods of operation at maximum performance are required.

The diagrams also reveal that the turbojet/ramjet combination is greatly superior in power to its turbojet component. The only objection which could be raised is that the enormous extra power supplied by the ramjet is not necessary if the turbojet alone is capable of propelling the aircraft at the required Mach number. This argument would be valid if the aircraft were required to fly only in a straight line.

But the situation is quite different when the aircraft must manœuvre, particularly at high altitudes. *Fig. 6* illustrates the load factors obtainable in turns at various altitudes by two hypothetical aircraft, both capable of flying at Mach 2.5, but one powered by a turbojet or turbojet-plus-rocket, and the other by a combined turbojet-plus-ramjet using the same turbojet.

The superiority of the turbojet/ramjet, as compared with the turbojet alone, is also seen from an examination of climb performance. This is due not only to its higher intrinsic thrust, but also to the fact that thrust increases greatly with increasing Mach number. Whereas in a pure jet aircraft the speed of optimum climb is always below the optimum supersonic flow speed for the engine, this is not the case for the aircraft powered by a turbojet/ramjet combination. In the latter, the rate of climb increases roughly as the cube of the Mach number. The only limitation is provided by the airframe strength or by a rapid falling off in air intake efficiency above a given Mach number.

At very high Mach numbers the turbojet/ramjet has other, secondary advantages over the pure turbojet. For example, the design of a turbojet becomes very complicated when the same engine has to be used for both take-off and flight at high supersonic speeds. For Mach numbers above 2, the air intake must be controllable so as to adapt the flow to changing conditions. The convergent-divergent exhaust must also be adjustable, despite the very high temperatures encountered in these regions.

Compared with these complications, the turbojet/ramjet is very much simpler. Up to something like Mach 3, it is possible, through judicious coupling of the air flows for the two engines, to operate with fixed-section air intake, since the air flows required for the turbojet and the ramjet vary in inverse proportion. Moreover, since the turbojet's thrust is only about one quarter of the total thrust, even a relatively large reduction in this thrust will have no great effect on the overall powerplant. A variable section for the jet exhaust pipe is also not required.

*

All these features make the turbojet/ramjet powerplant the propulsion system *par excellence* for aircraft required to combine very high level speeds with a high rate of climb and the greatest possible manœuvrability at all altitudes, that is, for *interceptors*. Thus, with engines not much different from those now in production, it is already possible to design aircraft whose performance will be limited only by thermal problems affecting the airframe or by operational necessity.

Dr. Ing. Jakob Ackeret

Professor of Aerodynamics at the Federal Institute of Technology, Zurich, celebrated his 60th birthday on March 17th, 1958. After completing his studies at the Federal Institute of Technology, Jakob Ackeret went to Göttingen in 1921, where Professor Ludwig Prandtl appointed him head of the Aerodynamische Versuchsanstalt a year later. His work on the aerodynamic behaviour of rotating cylinders (Flettner rotors) and the applications of boundary layer suction dates from this period. In 1927 he became Chief Hydraulics Engineer with the firm of Escher Wyss A.G., Zurich. In his inaugural lecture at the Federal Institute of Technology the following year he introduced the term Mach Number to designate the relation between an aircraft's speed and the speed of sound. In 1931 he was appointed Assistant Professor and in 1934 Professor of Aerodynamics at the Institute and head of the newly-formed Aerodynamics Department. It was here that the world's first closed circuit supersonic wind tunnel was constructed, in 1933/34.

Book Reviews

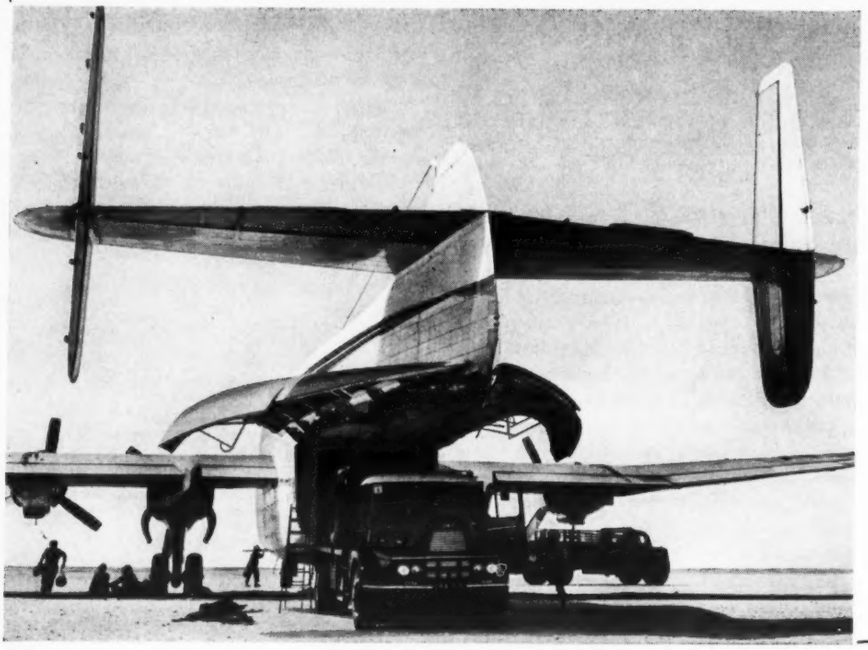
L'Aviazione Commerciale Italiana nel Quadro dei Traffici Aerei Mondiali. — By General Mario Porru. — Reprint of an article published in 1957, Rome, 1958 (Italian; 46 pages).

This instructive survey of Italian commercial aviation has attained added importance since the recent consolidation of the Italian airlines and the emergence of a single national flag carrier, Alitalia Linee Aeree Italiane. As Secretary General for Air and former Director General of Civil Aviation and Air Transport at the Defence Ministry, the author, known more widely as General Porru Locci, has played a leading part in preparing the future of Italian air transportation. In this booklet he outlines the present situation in his country's commercial aviation and its place in world air transport. The text is backed up by numerous coloured tables and maps. When it comes to predictions for the future, the author proceeds with the caution characteristic of those fully conversant with the background of their subject. An objective account of Italian air transport. He.

Starten und Fliegen. Das Buch der Luftfahrt und Flugtechnik. Volume II. Edited by Otto Fuchs, Wolfgang von Gronau, Richard W. Schulz. Deutsche Verlags-Anstalt Stuttgart, Stuttgart, 1957 (German; 384 pages, more than 250 illustrations; price, cloth-bound, DM 14.80).

The remarks made on the first volume of this book (*Interavia*, No. 2, 1957, p. 150), namely that it gave " an excellent picture of the many aspects of civil aviation today ", remain fully valid for the present second volume. A brief glance at the list of authors reveals that the editors have once again succeeded in finding the right man for the job: for example, Professor Walter Georgi (Deutsche Forschungsanstalt für Segelflug) writes on jet streams; Wolfgang von Gronau contributes a lively description of his 1930 seaplane flight across the Atlantic; Alfred Vermaaten (head of Lufthansa's flying training school at Bremen) describes the training of a commercial pilot; Bristol Aircraft Ltd. provides an illustrated report on the *Britannia's* final assembly ; F. H. Freiherr von Gablenz (Swissair captain) deals with the burning question of airborne radar; Rudolf Lange (board member of Flughafen AG Frankfurt/Main airport management company) discusses the construction of runways. The quality of presentation has not changed since the previous volume. He.

Avions Louis Breguet



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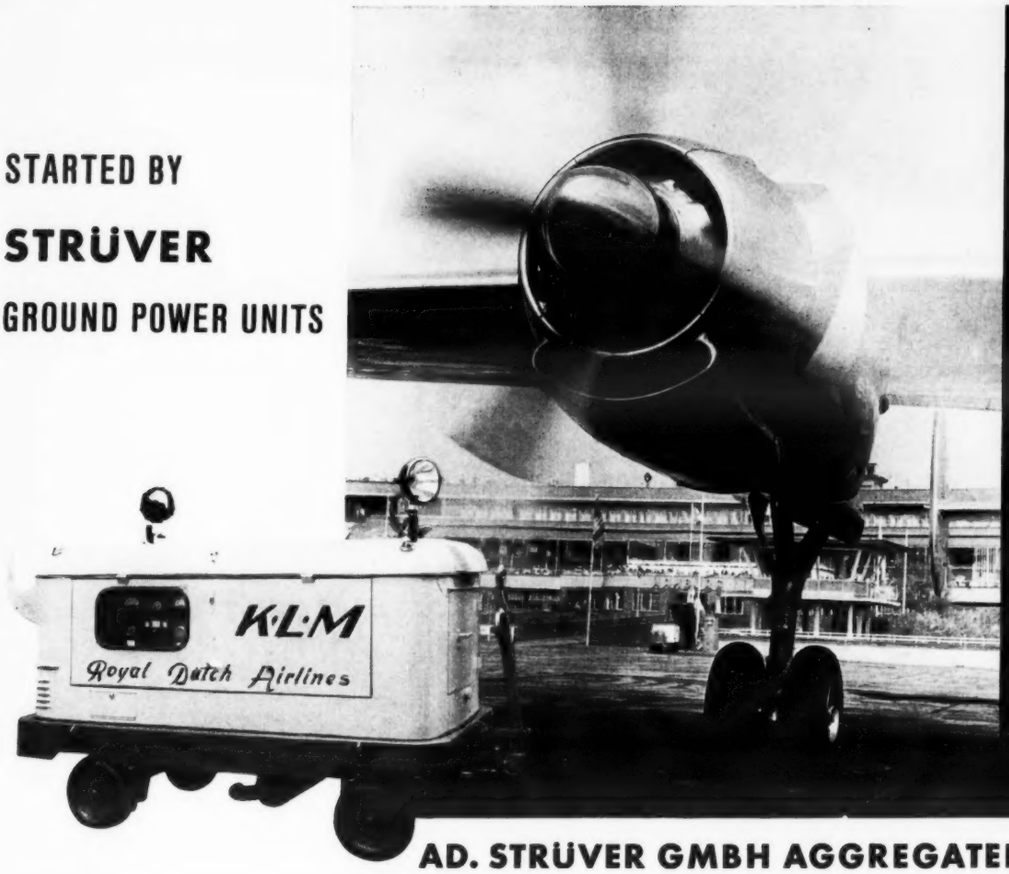

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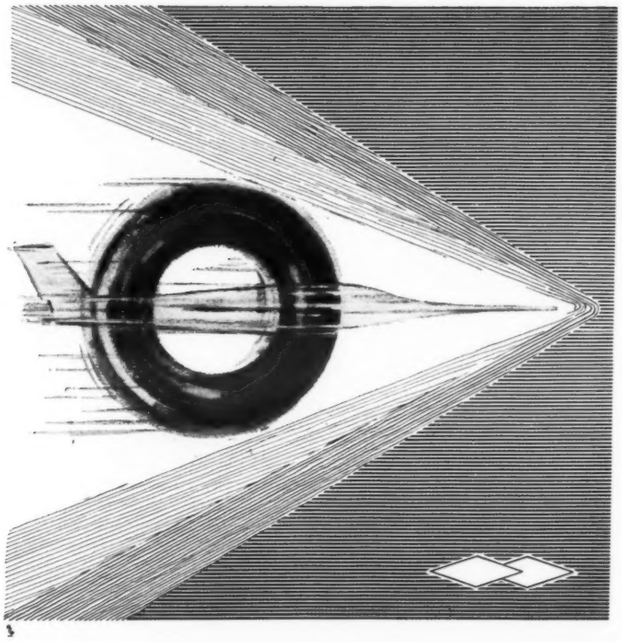

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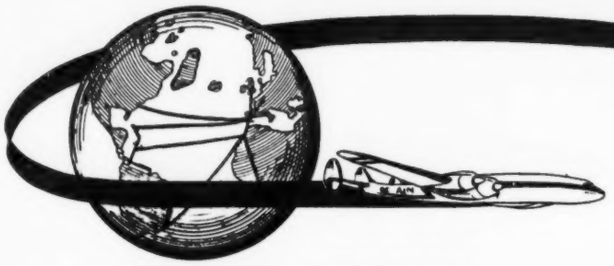

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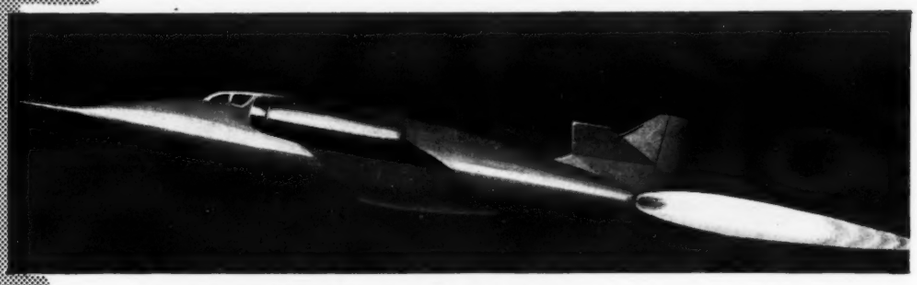

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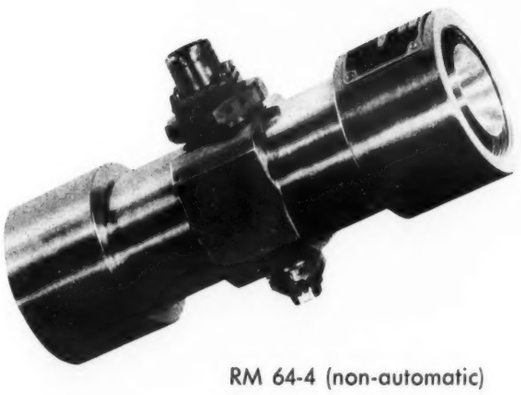

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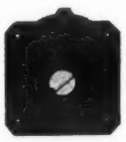

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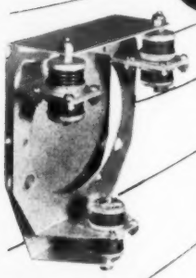

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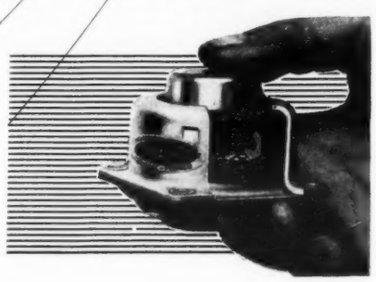

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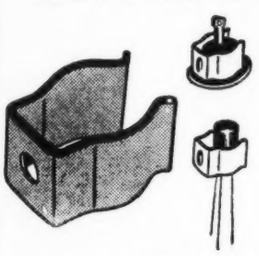

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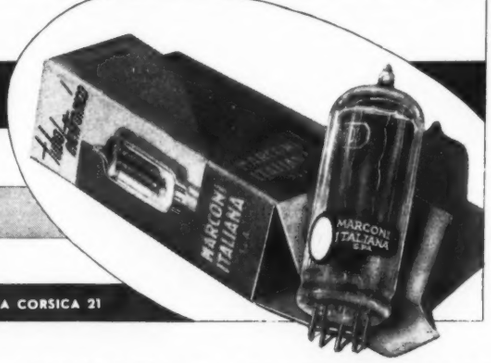

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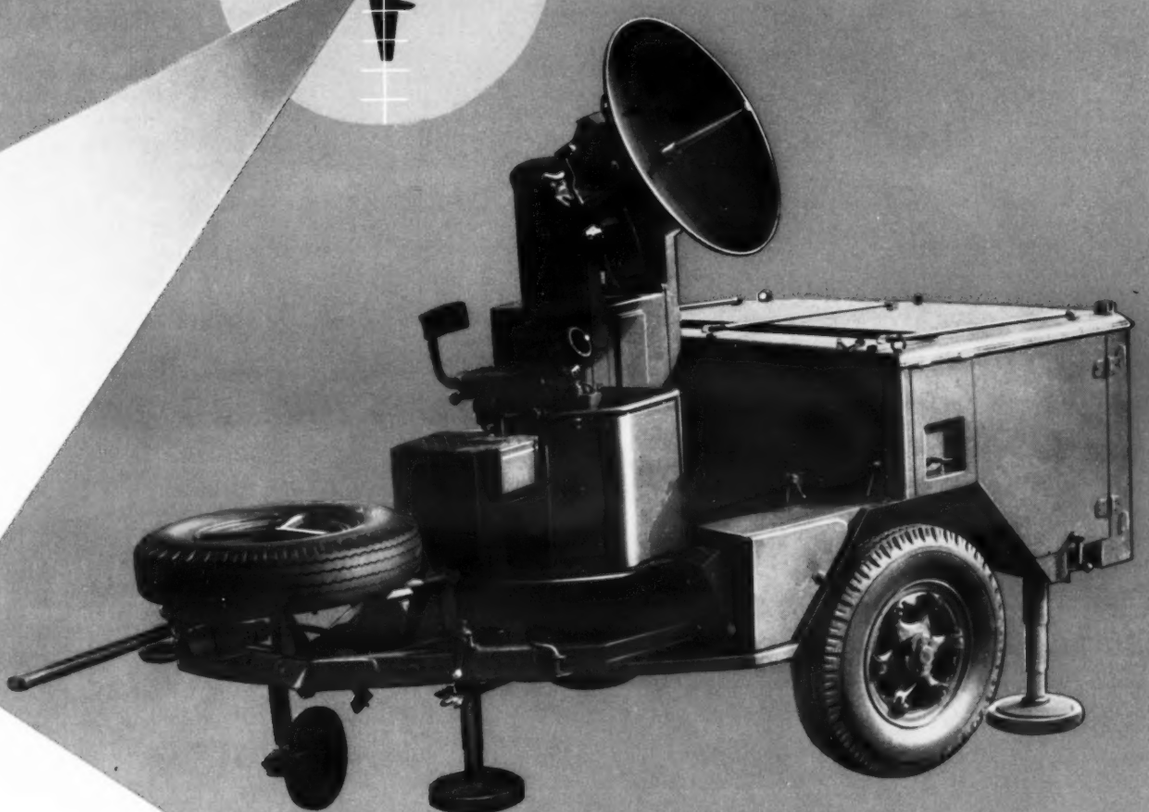

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